

The Journal of the American Association of Zoo Keepers, Inc.

# Animal Keepers Forum



May 2018, Volume 45, No. 5



learning  
partner

ASSOCIATION  
OF ZOOS  
AQUARIUMS &

# HOW

CAN YOU ADVANCE YOUR ZOOKEEPING CAREER?

**With an online education from the Animal Behavior Institute.**

Our programs in Zoo & Aquarium Science give you the training you need to grow and advance in your field.

Small class sizes and professional faculty guarantee you a personal education with the individual attention you deserve.

**START TODAY  
AND EARN YOUR  
CERTIFICATE  
IN AS LITTLE  
AS SIX MONTHS!**



*A more personal education*

Animaledu.com  
support@animaledu.com  
Toll free (866) 755-0448



**121 ABOUT THE COVER**

**122 FROM THE PRESIDENT**

**124 COMING EVENTS**

**125 ANNOUNCEMENTS**

**FEATURED ARTICLES**

**126-129**

Constraints of Hand-rearing in the Field: A case study with the Kirk's Dik-dik (*Madoqua kirkii*)

**Adam C. Stein, Viktoriia Kalinina and Brennen PetersonWood**

**130-134**

Differences in Behavior of Ring-tailed Lemurs and Tufted Capuchin Monkeys Between Indoor Housing and Outdoor Island Exhibits

**Katie Prinsen and Hollie Wells**

**SAFETY**

**135-138**

Preventive Maintenance

**Kathryn Juliano**

**ENRICHMENT OPTIONS**

**139-145**

Comparing Responsiveness of Nocturnal and Diurnal Primates to Different Sensory Enrichment Conditions

**Chris McGovern, Dr. Cheryl Frederick, and Dr. Jennifer Clark**



**Join AAZK today at [AAZK.org](http://AAZK.org)**

# feed me Please

**RODENTPRO.COM**<sup>®</sup>  
MICE • RATS • RABBITS • CHICKS • QUAIL

Value  
Quality  
Convenience

Discover what tens of thousands of customers—including commercial reptile breeding facilities, veterinarians, and some of our country's most respected zoos and aquariums—have already learned: with Rodentpro.com<sup>®</sup>, you get quality AND value! Guaranteed.

RodentPro.com<sup>®</sup> offers only the highest quality frozen mice, rats, rabbits, guinea pigs, chickens and quail at prices that are MORE than competitive. We set the industry standards by offering unsurpassed quality, breeder direct pricing and year-round availability.

With RodentPro.com<sup>®</sup>, you'll know you're getting exactly what you order: clean nutritious feeders with exact sizing and superior quality. And with our exclusive shipping methods, your order arrives frozen, not thawed. **We guarantee it.**

Order online  
[www.RodentPro.com](http://www.RodentPro.com)  
It's quick, convenient  
and guaranteed!

P.O. Box 118  
Inglefield, IN 47618-9998

**Tel: 812.867.7598**

Fax: 812.867.6058

E-mail: [info@rodentpro.com](mailto:info@rodentpro.com)





## MISSION STATEMENT

American Association of Zoo Keepers, Inc.

The American Association of Zoo Keepers, Inc. exists to advance excellence in the animal keeping profession, foster effective communication beneficial to animal care, support deserving conservation projects, and promote the preservation of our natural resources and animal life.

## ABOUT THE COVER

This month's cover features a Kirk's Dik-dik (*Madoqua kirkii*) by Adam C. Stein, PhD, Field Manager of Wildlife Connection in Tanzania. Adam's article on hand-rearing of Kirk's Dik-dik can be found on pages 126-129.

Kirk's Dik-dik are a small antelope species from east Africa. They are a fawn color, which is excellent camouflage in their savannah habitat. Males have stout horns often hidden by tufts of fur. This species of Dik-dik has an elongated snout that allows excess heat to be lost, lowering body temperature. Blood vessels close to the skin of the snout allows excess heat to pass to the air, cooling the blood that then returns to the body. All Dik-diks take their name from the call they make when startled. They will jump from their hiding place and move in a series of zigzag leaps while making the "dik-dik" call. This movement aims to confuse predators.

Dik-diks are active mostly in the early morning or late afternoon and evening. During the hottest part of the day, they curl up in the shade and rest. Every Dik-dik pair establishes a territory ranging in size from 12.5 to 75 acres. The pair walks its territory each day, browsing on leaves, buds, shoots, fruits and grasses. Most of the water they ingest comes from the plants that they eat.

Articles sent to *Animal Keepers' Forum* will be reviewed by the editorial staff for publication. Articles of a research or technical nature will be submitted to one or more of the zoo professionals who serve as referees for **AKF**. No commitment is made to the author, but an effort will be made to publish articles as soon as possible. Lengthy articles may be separated into monthly installments at the discretion of the Editor. The Editor reserves the right to edit material without consultation unless approval is requested in writing by the author. Materials submitted will not be returned unless accompanied by a stamped, self-addressed, appropriately-sized envelope. Telephone, fax or e-mail contributions of late-breaking news or last-minute insertions are accepted as space allows. Phone (330) 483-1104; FAX (330) 483-1444; e-mail is shane.good@aaazk.org. If you have questions about submission guidelines, please contact the Editor. Submission guidelines are also found at: [aaazk.org/akf-submission-guidelines/](http://aaazk.org/akf-submission-guidelines/).

Deadline for each regular issue is the 3<sup>rd</sup> of the preceding month. Dedicated issues may have separate deadline dates and will be noted by the Editor.

Articles printed do not necessarily reflect the opinions of the **AKF** staff or the American Association of Zoo Keepers, Inc. Publication does not indicate endorsement by the Association.

Items in this publication may be reprinted providing credit to this publication is given and a copy of the reprinted material is forwarded to the Editor. If an article is shown to be separately copyrighted by the author(s), then permission must be sought from the author(s). Reprints of material appearing in this journal may be ordered from the Editor. Regular back issues are available for \$6.00 each. Special issues may cost more.

## MEMBERSHIP SERVICES

Animal Data Transfer Forms available for download at [aaazk.org](http://aaazk.org). AAZK Publications/Logo Products/Apparel available at AAZK Administrative Office or at [aaazk.org](http://aaazk.org).

## ANIMAL KEEPERS' FORUM

TO CONTACT THE AKF EDITOR:

Shane Good, AKF Editor  
P.O. Box 535, Valley City, OH 44280  
330-483-1104  
Shane.Good@aaazk.org

## AAZK Administrative Office

American Association of Zoo Keepers  
8476 E. Speedway Blvd, Suite 204  
Tucson, AZ 85710-1728  
520-298-9688 (Phone/Fax)

CHIEF EXECUTIVE/FINANCIAL OFFICER: Ed Hansen  
E-mail: [Ed.Hansen@aaazk.org](mailto:Ed.Hansen@aaazk.org)

### ANIMAL KEEPERS' FORUM - EDITOR

Shane Good, [Shane.Good@aaazk.org](mailto:Shane.Good@aaazk.org)

### GRAPHIC DESIGNER

Elizabeth Thibodeaux, [Elizabeth.Thibodeaux@aaazk.org](mailto:Elizabeth.Thibodeaux@aaazk.org)

### ENRICHMENT OPTIONS COLUMN COORDINATORS

Stephanie Miner, Julie Hartell-DeNardo,

Beth Stark-Posta, Beth Ament-Briggs

### TRAINING TALES COLUMN COORDINATORS

Kim Kezer, Jay Pratte, Angela Binney

### CONSERVATION STATION COLUMN COORDINATOR

Lauren Augustine

### ANIMAL WELFARE COLUMN COORDINATORS

Stephanie Miner, Julie Hartell-DeNardo,

Beth Stark-Posta, Beth Ament-Briggs

## BOARD OF DIRECTORS AND OVERSIGHTS

**PRESIDENT:** Bethany Bingham, [Bethany.Bingham@aaazk.org](mailto:Bethany.Bingham@aaazk.org)  
Conference Manager

**VICE PRESIDENT:** Mary Ann Cisneros, [Maryann.Cisneros@aaazk.org](mailto:Maryann.Cisneros@aaazk.org)  
Ethics Chair  
Bylaws  
Program Chair: Rebecca Filippini, [Rebecca.Filippini@aaazk.org](mailto:Rebecca.Filippini@aaazk.org)

**BOARD MEMBER:** Bill Steele, [Bill.Steele@aaazk.org](mailto:Bill.Steele@aaazk.org)  
Awards Committee

Chair: Jan McCoy, [Awards@aaazk.org](mailto:Awards@aaazk.org)

Vice Chair: Erika Mittelman, [emittelman@safariwest.com](mailto:emittelman@safariwest.com)

### Grants Committee

Chair: Jessica Biggins, [Jessica.Biggins@aaazk.org](mailto:Jessica.Biggins@aaazk.org)

Vice Chair: Susie Kaplar, [philusiek@gmail.com](mailto:philusiek@gmail.com)

**BOARD MEMBER:** Azzara Oston, [Azzara.Oston@aaazk.org](mailto:Azzara.Oston@aaazk.org)  
Conservation Committee

Chair: Christy Poelker, [Christy.Poelker@aaazk.org](mailto:Christy.Poelker@aaazk.org)

### Bowling for Rhinos Program

Program Manager: Kym Janke, [Kym.Janke@aaazk.org](mailto:Kym.Janke@aaazk.org)

### Vice Manager: Vacant

### Trees for You and Me Program

Program Manager: Christy Mazrimas-Ott, [Christy.Mazrimas-Ott@aaazk.org](mailto:Christy.Mazrimas-Ott@aaazk.org)

Vice Manager: Anthony Nielsen, [Anthony.Nielsen@aaazk.org](mailto:Anthony.Nielsen@aaazk.org)

**BOARD OVERSIGHT:** Bethany Bingham, [Bethany.Bingham@aaazk.org](mailto:Bethany.Bingham@aaazk.org)

### Professional Development Committee

Chair: Ellen Vossekuil, [Ellen.Gallagher@aaazk.org](mailto:Ellen.Gallagher@aaazk.org)

Vice Chair: Kerri D'Ancicco, [Kerri.D'Ancicco@aaazk.org](mailto:Kerri.D'Ancicco@aaazk.org)

### International Outreach Committee

Chair: Yvette Kemp, [Yvette.Kemp@aaazk.org](mailto:Yvette.Kemp@aaazk.org)

Vice Chair: Noah Shields, [ncshield@gmail.com](mailto:ncshield@gmail.com)

**BOARD MEMBER:** Hardy Kern, [Hardy.Kern@aaazk.org](mailto:Hardy.Kern@aaazk.org)  
Communication Committee

Chair: James Weinpress, [James.Weinpress@aaazk.org](mailto:James.Weinpress@aaazk.org)

### AAZK Resource Committee

Chair: Robin Sutker, [Robin.Sutker@aaazk.org](mailto:Robin.Sutker@aaazk.org)

### Vice Chair: Vacant

### National Zoo Keeper Week Program

Program Manager: Kristen Scaglione, [Kristen.Scaglione@aaazk.org](mailto:Kristen.Scaglione@aaazk.org)

**BOARD MEMBER:** Paul Brandenburger, [Paul.Brandenburger@aaazk.org](mailto:Paul.Brandenburger@aaazk.org)

### Behavioral Husbandry Committee

Chair: Megan Wright, [Megan.Wright@aaazk.org](mailto:Megan.Wright@aaazk.org)

Vice Chair: Kaitlyn Wiktor, [Kaitlyn.Wiktor@aaazk.org](mailto:Kaitlyn.Wiktor@aaazk.org)

### Safety Committee

Chair: Kelly Murphy, [Kelly.Murphy@aaazk.org](mailto:Kelly.Murphy@aaazk.org)

Vice Chair: Sara Morris, [Sara.Morris@aaazk.org](mailto:Sara.Morris@aaazk.org)



***“Change the way  
you look at things  
and the things you  
look at change.”***

~ Wayne W. Dyer

I recently made a change in my life. I accepted the position of Development Coordinator at Utah's Hogle Zoo. For the past 21 years, I have focused my efforts on outstanding animal care and support for conservation. I realized that I wanted to change the way I look at things and that I want to do more. I'm eager to further develop my skills in the role of liaison between Zoo staff, animals and donors. I am excited about the opportunity to assist in providing engaging programs and to share creative exhibits with the guests and the local community through donor support. In the Development Department I believe my skills and experience, as well as my commitment to excellence will help me excel and bring a new point of view to the philanthropy experience.

This change in position represents a unique opportunity to utilize my passion for animals and my strengths in leadership, event planning and fundraising acquired through my experience with AAZK. I will be connecting donors and members of the community more closely with the animals at the Zoo. It is also an opportunity to share more than 20 years of experience gained while working with the animals and animal care staff at Hogle Zoo, first as a zoo keeper and then as a veterinary technician. I will now be working in collaboration with the animal care staff and many other departments at the Zoo, to provide engaging experiences and development opportunities, with an emphasis on the role zoos play in conservation.

By unanimous vote of the AAZK Board of Directors, the Board has elected to give me a continuance of office, retaining my current status as Board member and President of AAZK through the completion of my term at the close of the 2019 AAZK National Conference in Indianapolis. Your Board is doing excellent work and I look forward to leading you towards a future comprised of outstanding professional development, effective communication and stewardship for conservation. I also look forward to sharing my perspective as I embark on this new adventure.

In order for AAZK to continue to be a successful organization we need all of the members to play an active role. So whether you are a Professional Member and have been in the business for more than 10 years, an Affiliate Member whose role is as an outstanding zoo volunteer, or a Student Member just joining us to build a network for your future, we are all part of the same team. That team is dedicated to upholding the mission and vision of AAZK and providing the best platform possible for animal care. I encourage you to change and expand the way you think about things at your facility and within AAZK. Consider what your role is on your team and how you can make an impact.

Respectfully,

Bethany  
Bethany.Bingham@aazk.org



2401 Phoenix Ave NE  
 Albuquerque NM 87107  
[www.wildlifetoybox.com](http://www.wildlifetoybox.com)

A Proud Product Line of Desert Plastics

Phone: 1-866-793-0376 E-mail: [sales@wildlifetoybox.com](mailto:sales@wildlifetoybox.com)

## Product/ Service Information

### Ball Shapes

- Ball In Ball
- Ball
- Domes
- Fifty Fifty Ball
- Fling Around
- Jingle Ball
- Prima Rocker
- Rocky Lou Feeder
- Rocky Lou
- Scent Ball
- Snack Shack
- Two Timer
- Wobble Ball
- Ying Yang

### Wobble Items

- Tippy Tom
- Wobble Ball

### Cylindrical Shapes

- Animal Transport
- Cylinders
- Discs
- Feeder Tube
- Flipper Float
- Holey Roller
- Jungle Jim
- Lipped Rings
- Pills
- Round Houses
- Round Thingie
- Scratcher
- Tunnels

### Tire Shapes

- Cat Toy
- Runt Run
- Tire Feeder
- Tire

### Rectangular Shapes

- Animal Transport
- Boxes
- Frame
- Holey Moley
- Ice Cube
- Sanctuarie
- Tray

### Goofy Stuff

- Critter Corner
- Cube on a Stick
- Frame
- Funny Float
- Half Barbell
- Round Thingie
- Shroom Room

### Feeders

- Feeder Tubes
- Hay Buddy
- Rocky Lou Feeder
- Tire Feeder
- Ant-Proof Bowl
- Brainteaser Feeder
- Bamboozle Feeder

### Mirrored Items

- Looky Lou Feeder
- Looky Lou Marine
- Looky Lou Standard
- Replacement Mirror
- Mirror Cover

### Odd Stuff

- Bungees
- Carabiners
- Cleats
- Eyebolts
- Ropes

### Food Prep

#### Areas

- Cutting Boards
- Food Dispensers
- Sneeze Guards

#### Acrylics

- Station Markers
- Risers
- Literature Holders
- Cases

# COMING EVENTS

Post upcoming events here!  
e-mail [shane.good@aazk.org](mailto:shane.good@aazk.org)

**June 20-23, 2018**  
**2018 International Herpetological Symposium (IHS)**  
Houston, TX  
Hosted by the East Texas Herpetological Society and Houston Zoo  
Go to: [internationalherpetologicalsymposium.com/](http://internationalherpetologicalsymposium.com/)

**July 22-28, 2018**  
**Felid TAG Meeting and Husbandry Course**  
Fresno, CA  
Hosted by the Fresno Chaffee Zoo  
For more information go to: <https://www.facebook.com/felidtag/>

**August 12-15, 2018**  
**2018 Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles**  
Fort Worth, TX  
For more information go to: [turtlesurvival.org/conference#](http://turtlesurvival.org/conference#).  
WqaSnqJld-Y

**August 23-25, 2018**  
**International Symposium on Pangolin Care and Conservation**  
Brookfield, IL  
Hosted by Chicago Zoological Society  
For more information contact: [amy.roberts@czs.org](mailto:amy.roberts@czs.org)

**August 26-29, 2018**  
**Association of Zoo Veterinary Technicians**  
Columbus, OH  
Hosted by Columbus Zoo and Aquarium  
For more information go to: [azvt.org](http://azvt.org)

**September 17-28, 2018**  
**Smithsonian-Mason School of Conservation. Ecology and Conservation of Migrating Birds**  
Front Royal, VA  
For more information go to: [smconservation.gmu.edu](http://smconservation.gmu.edu)

**September 23-27, 2018**  
**AZA Annual Conference**  
Seattle, WA  
Hosted by Seattle Aquarium and Woodland Park Zoo  
For more information go to: [aza.org/conferences-meetings#mym](http://aza.org/conferences-meetings#mym)

**October 14-18, 2018**  
**International Congress on Zookeeping**  
Buenos Aires, Argentina  
Hosted by Fundacion Temaiken and the International Congress of Zookeepers  
For more information go to: [iczoo.org/congress](http://iczoo.org/congress)

**October 15-20, 2018**  
**Otter Keeper Workshop**  
Portland, OR  
Hosted by Oregon Zoo  
For more information go to: [otterkeeperworkshop.org/](http://otterkeeperworkshop.org/)



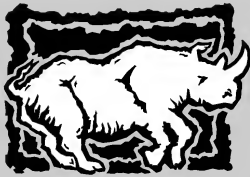
**October 4-8, 2018**  
**AAZK National Conference**  
Denver, CO

*Hosted by the Rocky Mountain AAZK Chapter and Denver Zoo*

[rmaazk.org/2018-national-aazk-conference/](http://rmaazk.org/2018-national-aazk-conference/)

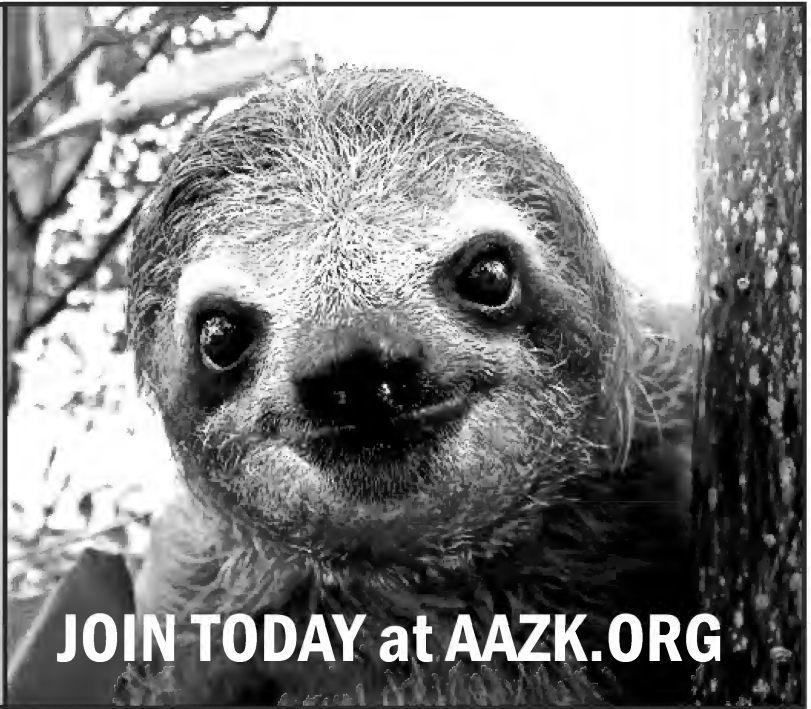
**October 25-27, 2018**  
**Waterfowl Conservation Workshop**  
Greenville, NC  
Hosted by International Wild Waterfowl Association and Sylvan Heights Bird Park  
For more information go to: [waterfowlconservation.org](http://waterfowlconservation.org)





**AMERICAN  
ASSOCIATION**  
of ZOO KEEPERS

Membership with the American Association of Zoo Keepers includes a subscription to the Animal Keepers' Forum, member rates for AAZK events and products, access to the Members Only section of [aazk.org](http://aazk.org), plus much more!



**JOIN TODAY at [AAZK.ORG](http://AAZK.ORG)**

**The June AKF will  
celebrate Aquarium  
Professionals Week and  
World Oceans Day!**



# Constraints of Hand-rearing in the Field: A case study with the Kirk's Dik-dik (*Madoqua kirkii*)

Adam C. Stein, Viktoriia Kalinina and Brennen PetersonWood  
Wildlife Connection  
Ruaha National Park, Tanzania

## Introduction

Hand-rearing exotic animals is now more of a precise science than an intuitive art due to advances in technology, refinement of nutritional requirements, modern veterinary care, instruments for tracking development, and advanced preparation for individual care. Additionally, following the successful hand-rearing of a species, the proven techniques can easily be communicated to other interested parties. However, there are circumstances where the benefits of twenty-first century hand-rearing are unavailable; biologists conducting research and conservation in remote field sites may at times be confronted with the decision of taking in an injured or orphaned animal encountered in the field. The ethics of whether the biologist should intervene must be evaluated on a case-by-case basis, but a consensus on which action to take is rarely unanimous. If the decision to care for an animal has been reached, there are different variables to contend with— variables that are often absent in captive settings. The most obvious challenges are meeting the nutritional requirements and providing medical care. In addition, proper confinement, access to materials such as feeding devices (e.g. bottles, eyedroppers, etc.), or even the ability to store perishable items like medication, formulas, etc. may prove difficult. Conversely, a challenge like proper temperature,

humidity or substrate maintenance may not be as big of an issue as it would be in a captive situation. Another important aspect to raising an animal in its natural habitat is combating natural predators or parasites. Creative and low tech solutions invented to tackle these issues combined with notes on behavior in a semi-captive native environment could be insightful to zoological institutions.

Here we present a unique situation in which we attempted to hand-rear an orphaned Kirk's Dik-dik, *Madoqua kirkii*, at our field site in Southern Tanzania. The genus *Madoqua* consists of four dwarf antelopes native to East and South Africa. Dik-diks are popular in zoological parks and information on hand-rearing dik-diks is readily available (Hammer and Hammer, 2004). Kirk's Dik-diks live in various habitats that provide good cover but not dominated by thick, tall grasses (Kingdon, 1997). They are browsers observed to eat leaves, fruits and shoots and to obtain their water intake from the plants they consume. Adults are monogamous and pairs share territories that range from 5-35 ha. Pair and family bonds are maintained through social grooming, vigilance behavior and dunging ceremonies (defecating together in territorial boundary markers). Females give birth to one offspring after a six-month gestation. Mothers leave offspring hidden in thickets near family resting sites, returning to nurse at various intervals during the day. The young finish suckling at each interval within minutes, but the female will stay near the young after each feeding for 10-15 minutes to allow the offspring to "frisk" and move about. Females lactate for approximately six weeks and young Dik-diks are weaned and disperse from their parents' territory after 6-9 months (Nowak, 1991).

**Photo 1.** The young Kirk's Dik-dik at the Maasai village on May 18, 2017. It had been discovered and taken from the wild by children from the village two days prior. The close proximity to domestic livestock during this period may have been where the Dik-dik was originally infected with parasites. Photo courtesy of Viktoriia Kalinina.



## Methods

On 17 of May 2017, we were shown a cellphone video of locals from a nearby Maasai community in possession of a newborn Kirk's Dik-dik. The following morning we travelled to the community to gain a better understanding of the story behind this young Dik-dik. We discovered that the Dik-dik was found by some of the Maasai children while they were walking in the bush on the 16<sup>th</sup> of May. Out of curiosity, they took it back to the community and placed it with other young livestock (goats, cows, dogs, and cats; Photo 1). The villagers assumed that the Dik-dik would suckle from one of the lactating female goats and therefore made no additional effort to care for the Dik-dik. Upon our arrival, it was evident to us that the Dik-dik was dehydrated and hungry; we made the decision to take it back to our camp in an attempt to care for it.

Immediately upon arriving at our camp, we injected 10 cc's of lactated Ringer's solution subcutaneously and gave a general health check. The right ear had a large scrape on the back side so we liberally applied Neosporin® cream on it. We adopted a feeding protocol that called for feedings at 0800, 1000, 1300, 1600, and 2000 for the first 7 days; from day 8 to day 30, we altered the feeding times to 0700, 1100, 1600 and 1900. We attempted to ensure that the combined daily feedings equated to roughly 15% of its total body weight. We did not have the ability to weigh the Dik-dik in camp, so we assumed that its weight on arrival was close to those reported for other newborn male Kirk's Dik-diks, which average 795 grams (Estes, 1991). We were constrained on options regarding a food source for the Dik-dik, so we relied on the only available resource: Nestle NIDO powdered milk. We mixed 50% water to 50% powder. A 140 cc syringe was used as a bottle (Photo 2).

For the first few days, we stimulated it to defecate using a warm wet rag. After two feedings, the young Dik-dik learned to accept the syringe and began to suckle it without struggle when it was presented at the appropriate feeding times. After each feeding we would stay with the Dik-dik for about 10-15 minutes to encourage exploration and movement. Between feedings, the Dik-dik would bed down in the bush within twenty meters of our living space (Photo 2).

For the first two weeks, the Dik-dik would sleep in our tent (Photo 3) because this was the only location that was safe from the nocturnal predators that frequented our bush camp (e.g. hyenas, jackals). A secured crate was then constructed adjacent to the tent where the Dik-dik could spend the night (Photo 4). Each morning after the first feeding, we would take the Dik-dik on a 30-45 minute walk around the perimeter of our bush camp, providing the Dik-dik an opportunity to practice running and to get an understanding of the environment.

Our five ha bush camp is located in the village lands near the boundary of Ruaha National Park. The camp contains substantial natural vegetation and cover, allowing a resident population of Kirk's Dik-diks to thrive. Our goal was to raise the Dik-dik in the most natural environment at the bush camp and, after weaning, allow the Dik-dik to transition to a fully wild existence. After 20 days with us, the Dik-dik began to browse on the various vegetation around camp. One of our limitations as foster parents was our inability to differentiate between edible and inedible plants. Therefore, we were relieved when the Dik-dik demonstrated an ability to experiment until it discovered edible plants for itself. Our observations determined that it consumed roughly 15 species of plants, although six species were commonly sought out (photo 5). It also regularly consumed commonplace dry fallen leaves.

The Dik-dik's energy level, behavior, and activity patterns were normal and anticipated until the 18 of June. At this point, it refused to accept a bottle for two consecutive feedings. Because it was still observed eating foliage and its energy level was still normal, we assumed that it must be making a transition to solid food. It refused to nurse again the following day; however, at this point it had become lethargic. This did cause concern and we attempted to diagnose in order to potentially treat. To keep it hydrated and energized, we made a bottle of Oral Rehydration Salts (ORS), but it refused this as well. We then offered it a mixture of ORS with chamomile tea, which it readily accepted. The following day, its energy level had increased; effectively, we now fed the chamomile tea mixture in place of the milk as a precaution that the Nestle



**Photo 2.** A typical feeding of the Dik-dik. Nestle NIDO powdered milk formula was offered at scheduled feeding times and administered in a 140 cc syringe. After each feeding the Dik-dik would bed down in the natural vegetation surrounding camp (captured in background). Photo courtesy of Adam C. Stein.



**Photo 3.** A typical night during the first two weeks raising the Dik-dik. Our tents were the safest place for the Dik-dik from nocturnal predators that frequented the camp. Photo courtesy of Viktoriia Kalinina.

NIDO may have been the cause of the issue. The Dik-dik continued to browse on natural foliage. On July 21, it was eating substantial amounts of vegetation and was taking two bottles of chamomile tea, but its lethargy continued. The fact that we had not seen it defecate within 50 hours led us to a theory that it may have become constipated due to the switch to solid food. We administered an enema the afternoon of the 21<sup>st</sup>, after which it promptly defecated solid, healthy-looking feces. Its energy level increased that evening and we were relieved to have discovered the cause and cure of the lethargy. On the morning of the 22 of June, the Dik-dik's energy level was at its lowest. We now feared that it had an infection, and an effort was made to get livestock antibiotics out to the field site. Unfortunately, the Dik-dik passed away later that morning before the medication arrived.



**Photo 4.** The crate that was constructed to keep the Dik-dik safe at night. The crate was constructed with branches and natural grasses. The walls were approximately 2.5 cm thick to hinder predators. The structure measured approximately 78 cm high, 72cm wide, and 104 cm long. **A.** A view of the outside of the crate, highlighting the door that opened up and down with a rope hinge. **B.** An inside view that shows the space available to the Dik-dik. Photos courtesy of Adam C. Stein.

It was decided to perform a necropsy in an effort to shed light on the Dik-dik's decline and death. The necropsy was performed with the remote guidance of a veterinarian. The digestive tract was normal and the stomach was full of digested vegetation. All other organs appeared normal, with the exception of the liver. The liver was infested with corrugated fibrous nodules (Photo 6). This indicated a long infection with a parasite that most likely caused its death.

### Conclusion

The Dik-dik most likely passed away from a long-term parasite infection. The source of this infection will never be determined, but it is possible that the Dik-dik became infected during the 48 hours it spent in the Maasai village in close contact with domesticated animals. Dik-diks, along with several other antelopes, engage in selective defecation practices, where individuals defecate in particular locations (Ezenwa, 2004). One hypothesis for this behavior is to reduce parasite transmission (Ezenwa, 2004). If this is indeed the case, it is plausible that Dik-diks are sensitive to parasites, which could explain the rapid inoculation during its time in the village. We did not have the capacity to identify the parasite responsible for the nodules on the liver, but certain parasites (e.g. *Echinococcus* sp), use herbivorous animals as intermediate hosts. The eggs of these parasites can be picked up from infected feces where they hatch into embryos in the intestine. The embryos penetrate the intestinal lining where they are carried in the blood stream to major organs such as the liver. Here they develop into numerous cysts that can kill the intermediate host (Brunetti and Filice, 2015).

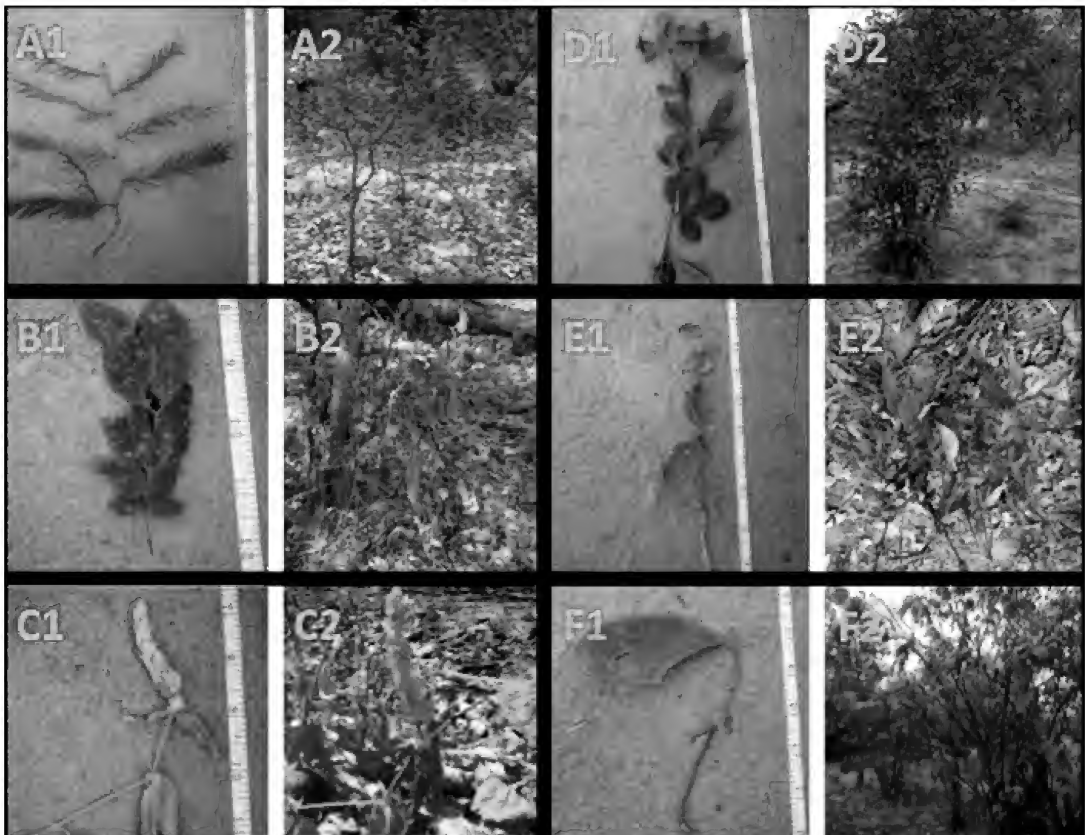
Given the constraints of the field, we were unable to treat for parasites preemptively, but even if we knew it was infected the opportunity to treat successfully would have been questionable. Conversations with others in the field who have attempted to raise Dik-diks under similar circumstances indicate that similar outcomes

are common. Although we did not successfully hand-rear this Kirk's Dik-dik to adulthood, we feel that our experience could prove useful for zoo professionals for the following reasons; 1) If it did indeed become infected during its close contact with livestock, this could highlight a potential conservation concern in environments where livestock and Dik-diks share habitat and interact, 2) It is difficult to find detailed information about what type of vegetation Dik-diks feed on in the wild—our observations identify several species of plant that were preferred, and 3) It suggests that even a simple 50/50 ratio of powdered milk could be sufficient to raise a Kirk's Dik-dik.

Hand-rearing animals in field conditions versus captive settings comes with a new set of challenges that need to be overcome. In this particular case, knowing the condition of the animal beforehand led to our failure. This challenge is faced by rescue centers the world over, but one that is minimized in a zoological setting. In addition, access to medical care or medication is limited. We faced the challenge of locating vets and describing symptoms over the phone or through pictures instead of having a personal visit. It would be highly unlikely that we could obtain the proper medication even if the infection was diagnosed earlier. Obtaining and administering the proper food could prove difficult, and in our situation, the use of a readily available powdered milk formula seemed to suffice. The last challenge is being prepared in advance to care for an animal. Given enough preparation, one could overcome many challenges faced with raising an animal in the field, but with only a day's notice, securing the equipment, space and schedule to care for an animal can be one of the biggest challenges. Despite these challenges and various potential unexpected outcomes, having the opportunity to hand-rear an animal in the field provides an unparalleled experience that will allow the handlers an intimate view of nature.

### Acknowledgements

We would like to thank John Mingwa and the Maasai community



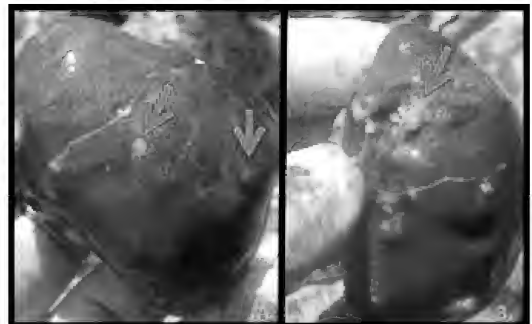
**Photo 5.** Plants consumed by the young Kirk's Dik-dik. **(A1&2)** *Dichrostachys cinerea*, **(B1&2)** unidentified **(C1&2)** *Justicia betonica* **(D1&2)** *Vitex mombassensis*, **(E1&2)** unidentified **(F1&2)** *Grewia pachcalyx*. Photos courtesy of Viktoriia Kalinina.

for allowing us to take the Dik-dik from their possession. We are also grateful to Beryl Patterson and Jamie Maurer for providing materials regarding hand-feeding regiments and to Scott Houser and Jessica Manzak for their veterinarian insights. Lastly, we thank Trevor Ritland for reviewing the manuscript.

## References

- Brunetti, E., and C. Filice. Echonnococcosis Hydatid Cyst. [medscape.com](http://medscape.com). 8 April 2015. Date accessed 29 August 2017.
- Estes, R.D. 1991. The behavior guide to African animals. The University of California Press, Berkeley, California U.S.A.
- Ezenwa, V.O. 2004. Selective defecation and selective foraging: Antiparasite behavior in wild ungulates? *Ethology* 110: 851-862.
- Kingdon, J. 1997. The Kingdon field guide to African mammals. Academic Press, London.
- Hammer, C. and S. Hammer. 2004. Hand-raising a Dik-dik antelope (*Madaqua saltiana phillipsi*) at Al Wbra Wildlife Preservation, Qatar. *Zool. Garten N.F.* 1:1-7.
- Nowak, R.M. (ed). 1991. Walker's Mammals of the World. Vol II Baltimore: Johns Hopkins University Press. 🐘

**Photo 6.** Photos of the liver from the necropsy. **A.** A view of the numerous cysts that were visible on the liver. **B.** A cyst that had been cut open to expose the corrugated, fibrous nodules. Photos courtesy of Adam C. Stein.



# Differences in Behavior of Ring-tailed Lemurs and Tufted Capuchin Monkeys Between Indoor Housing and Outdoor Island Exhibits

*Katie Prinsen and Hollie Wells, Keepers  
Rolling Hills Zoo  
Salina, KS*



*Capuchin. Photo by Katie Prinsen.*

## Abstract

Data were collected to evaluate the activity patterns of 3.0 ring-tailed lemurs *Lemur catta* and 0.3 tufted capuchins *Cebus apella* housed at Rolling Hills Zoo. The ring-tailed lemurs and tufted capuchins were observed in both their indoor winter exhibits and outdoor summer exhibits to determine if a more natural exhibit encourages more species-specific behaviors and if their indoor exhibit is adequate for expression of these behaviors. One-zero sampling was used to score eight different behaviors from each individual over a period of 10 days for both indoor and outdoor exhibits. Each study day consisted of two 20-minute periods of observation and behaviors were scored at one-minute intervals. For the group of ring-tailed lemurs inactivity was the most noted behavior in their indoor exhibit whereas grooming and sleeping were the most observed behaviors when housed outdoors. The second highest scored indoor behavior for ring-tailed lemurs was grooming. For the group of tufted capuchins movement through exhibit was the most noted behavior in their indoor exhibit followed by grooming and vocalizing. The most observed behavior for tufted capuchins while housed outdoors was foraging followed by grooming. The results suggest that for ring-tailed lemurs additional and improved resting places that are more secluded from public viewing could be offered in their indoor exhibit and for tufted capuchins additional and improved foraging options could be offered in the indoor housing to encourage more natural behaviors and better meet their needs. Additionally a more behavior-targeted enrichment plan could be added to decrease inactivity for both ring-tailed lemurs and tufted capuchins, particularly while housed indoors.

## Introduction

At the time of the study Rolling Hills Zoo housed 3.0 ring-tailed lemurs, aged 14, 15 and 16 years and 0.3 tufted capuchins aged 23, 31 and 31 years. Two of the ring-tailed lemurs housed here were born at Rolling Hills Zoo; the other ring-tailed lemur was transferred from another zoo at one year of age and has resided at Rolling Hills Zoo for the following 15 years. All three of the tufted capuchins at this facility were donated from a research institution 18 years prior to the study.

At Rolling Hills Zoo these species spend approximately seven months of the year in their indoor enclosures which are perched mesh exhibits with no access to the outdoors and minimal natural lighting. The indoor lemur exhibit has approximately one yard of separation between the guest barrier and the entire front side of the exhibit. The capuchin indoor exhibit is slightly more secluded having approximately seven yards of separation between the guest barrier and their exhibit on each end. Additionally these indoor enclosures are located in shared buildings in very close proximity to other species. Due to the joint housing the lemurs are also exposed to the strong odors and noises of 1.0 Indian rhinoceros, 2.2 white rhinoceros, and 0.3 cotton-top tamarins. The capuchins share a barn with 1.2 reticulated giraffes, and 1.1 green-winged macaws and therefore are exposed to the sounds and smells of those species.

The remaining five months of the year these species are housed on more secluded outdoor island exhibits. These exhibits include structures for shelter and perching is offered in addition to the naturally growing trees and brush. The guest viewing areas and the outer edges of the islands are separated by approximately 10 yards of water. This is a unique set-up for these species to have different housing throughout the year, one being more natural and the other much less natural. Comparing behaviors and spatial usage in each



Lemurs at Rolling Hills Zoo on island exhibit grooming each other.  
Photo by Hollie Wells.

exhibit for each species allows a better understanding of the effects of the indoor and outdoor exhibits on behavior and potentially mental health. This study looks at the two different environments to determine whether or not a more natural environment encourages more natural behaviors in these species.

## Methods

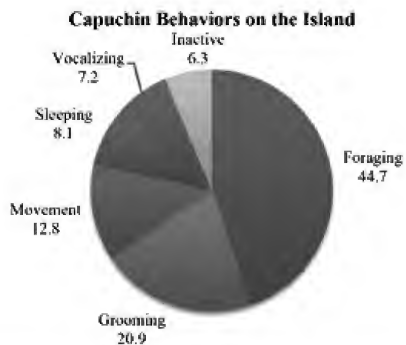
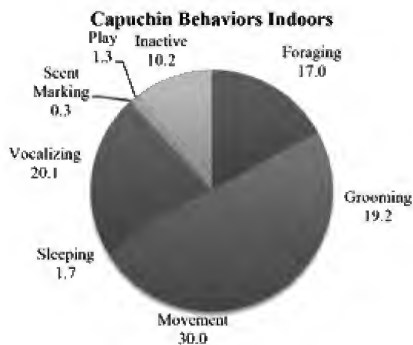
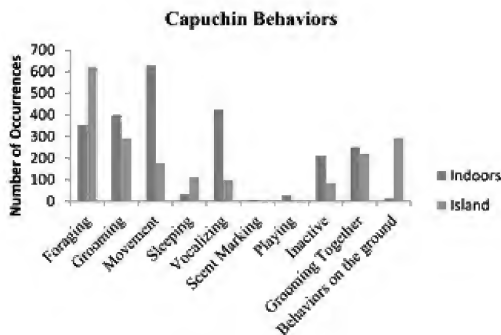
Both species were observed in their indoor and outdoor exhibits for 10 days within a two-week period. The first study period began on 2 May 2016 at the indoor exhibits and the second study period began on 25 June 2016 at the outdoor exhibits. Each observation day consisted of two observation periods per day for 20 consecutive one-minute intervals at approximately 1030 and 1430. The one-zero sampling method was used and the behaviors were defined as states. A behavior was counted once per animal within each interval if they exhibited that behavior within that one-minute interval.

Throughout the study phases each species was offered the same enrichment of elm browse, balls, and a set of toddler toys given around eight in the morning that was removed around 4:30 in the afternoon. The enrichment items were given without food or sensory additions. The following are the behaviors chosen for the ethogram and the definitions used for this study: foraging, defined as eating or looking for food by digging, moving rocks, turning over bark, leaves, or branches; grooming, defined as using mouth or hands to clean or maintain hair coats, this was also divided into subcategories of allogrooming or self-grooming; sleeping, defined as rest or nap-like behavior, eyes closed and no movement for at least 15 seconds; vocalizing, defined as any audible noise exhibited internally from the animal; scent marking, defined for lemurs as rubbing wrists or anal area on an object, and defined for capuchins as using their tail to rub smells on self or objects; playing, defined as interaction with provided enrichment or non-aggressive interaction

Capuchins at Rolling Hills Zoo on island exhibit grooming each other  
Photo by Leah Hovenier.







Capuchin outdoor island exhibit. Photo by Hollie Wells.



with one another that is not grooming; inactivity, defined as sitting, watching, picking at objects, any behavior with seemingly no purpose; and movement, defined as traveling from one part of the exhibit to another or anything that changes their physical location where active foraging is not observed. All behaviors observed were also noted to have occurred either on or off the ground.

Data were recorded by the same three individuals: two primary keepers and one additional keeper. For the indoor lemur study observations were taken from the guest viewing, approximately two yards from the front of the exhibit. Outdoor lemur observations were taken on the island with the lemurs. For the indoor capuchin study the keeper observed the capuchins from the keeper space which is inaccessible to guests, approximately five yards from the exhibit. Outdoor observations of the capuchins were taken from the guest viewing area on the other side of the water across from the island. To verify that the data observed in person were not noticeably affected by the presence of the observer, two sessions were video recorded and then reviewed to rule out any major differences in behavior.

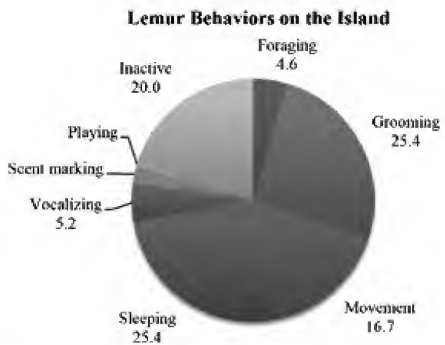
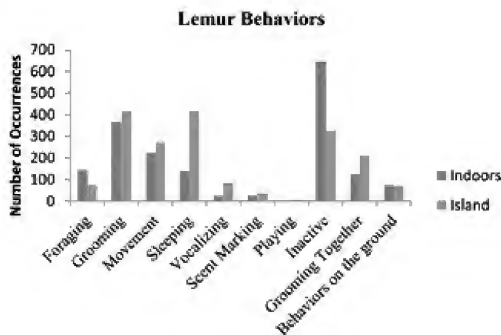
## Results

Recorded occurrences of behaviors were totaled for each individual and then added together for each species for each exhibit type. Results for lemurs and capuchins are shown in Figures 1 and 2. For lemurs, 1,639 data points were collected from island housing and 1,573 data points from indoor housing for a total of 3,212 data points. For capuchins, 1,388 data points were collected from island housing and 2,090 data points were collected indoors for a total of 3,478 data points. Differences were discovered in the number of behavior occurrences between indoor and outdoor exhibits for both species. Total percentage of occurrences of each behavior out of all occurrences is shown in Figures 3 through 6.

On the island, lemurs showed a greater number of occurrences of grooming, movement, sleeping, vocalizing, scent marking, play, and time spent grooming together. While indoors, the number of occurrences of foraging, inactivity, and time on the ground was greater than on the island. Lemurs had the greatest percentage of occurrences of inactive behavior indoors, 41.1% versus 20.0% on the island. Outdoors the greatest percentage of occurrences of behavior were sleeping and grooming. Behaviors on the island that had a greater percentage of occurrences than indoors were: grooming by 2.1%, movement by 2.5%, sleeping by 16.5%, vocalization by 3.6%, scent marking by 0.6%, play by 0.3%, and time spent allogrooming versus self-grooming by 16.6%. Behaviors that had a greater percentage of occurrences indoors were: foraging by 4.6%, inactivity by 21.1%, and behaviors spent on the ground by 0.2%. Overall lemurs spent the majority of their time off the ground, 4.7% of occurrences of behaviors indoors and 4.5% outdoors.

On the island, capuchins showed a greater number of occurrences of foraging and sleeping, and more instances of behaviors occurring on the ground. Indoors capuchins showed a greater number of occurrences of: grooming, movement, vocalization, scent marking, play, inactivity, and time spent grooming each other versus self-grooming. Capuchins had the greatest percentage of occurrences of behavior of movement indoors. Outdoors the greatest percentage of occurrences of behavior was foraging. Behaviors on the island that had a greater percentage of occurrences than indoors were: foraging by 27.7%, grooming by 1.7%, sleeping by 6.4%, behaviors occurring on the ground by 20.3% and time





Lemur outdoor island exhibit. Photo by Leah Hovenier.



spent grooming together by 13.3%. Behaviors that had a greater percentage of occurrences indoors were: movement by 17.2%, vocalization by 13.1%, scent marking by 0.3%, play by 1.3% and inactivity by 3.9%. Indoors 0.8% of occurrences of the capuchins behavior occurred on the ground versus 21.1% of occurrences on the ground on the island. Capuchins had a greater number of occurrences of grooming indoors, but outdoors they had a greater percentage of occurrences of grooming.

## Discussion

The major differences found for lemurs were that on the island the lemurs spend the majority of their time between grooming and sleeping. While housed indoors, lemurs spend the majority of their time inactive followed by grooming.

Capuchins spend the majority of their time outdoors foraging followed by grooming. Indoors capuchins spend the majority of their time moving followed by vocalizing and grooming. Time on the ground was greater outdoors.

Some factors in this study could have influenced the results. Different times of the day, number of guests and different temperatures may result in an increase or decrease in certain behaviors. Data could change if enrichment had been chosen at random. Vocalizing was harder to hear on the islands and at times some individuals were out of view, particularly on the capuchin island exhibit, so we may have missed some occurrences of behaviors.

For future studies, behaviors with the greatest percentage of occurrences and with the greatest differences indoors versus outdoors could be studied further, using random time sampling to obtain actual amounts of time spent doing behaviors. Since there is a large increase in foraging for capuchins outdoors versus indoors a more complex indoor habitat and enrichment program could be provided and time sampling could be used to measure foraging to see if there was success in replicating their outdoor environment. Both species may not be as comfortable sleeping in their indoor exhibits during zoo operating hours so providing more secure spaces for them and then measuring the amount of time they spend sleeping after the modifications could determine if the changes improved their indoor exhibits to fit their needs.

Overall the data may indicate lemurs and capuchins could benefit from housing modifications to increase certain behaviors to levels more similar to wild groups of these species. Ring-tailed lemurs in the wild have been found to be more active than ring-tailed lemurs in captivity (Shire, 2012). Rolling Hills Zoo lemurs spent a lot of time inactive, particularly indoors, compared to wild ring-tailed lemurs studied using continuous time sampling in two habitats at Berenty Reserve in Madagascar which spent 20.5% of their time sitting inactively in spiny forests and 14.8% in gallery forest (Ellwanger and Gould, 2011). Lemurs at Rolling Hills Zoo had a low number of occurrences foraging indoors and outdoors. Captive reared ring-tailed lemurs released on St. Catherine's Island, Georgia showed an increase in activity after release and time spent foraging was 26% (Keith-Lucas et al., 1999). An increase in targeted enrichment offered and indoor exhibit alterations could decrease lemur inactivity indoors and increase foraging overall. Providing browse has been found to increase activity in captive ring-tailed lemurs (Dishman et al., 2009). Maloney et al. (2006) found that lemurs given food enrichment that required manipulation responded with a decrease in resting and an increase in playing and grooming.



Indoor capuchin exhibit. Photo by Hollie Wells.



Indoor lemur exhibit. Photo by Hollie Wells.

For capuchins, foraging opportunities could be increased indoors as they spend a majority of their time doing this activity outdoors. Wild capuchins spend about 50% of their day foraging (Fragaszy, 2005). A study of laboratory tufted capuchins found that providing enrichment increased foraging and other natural behaviors, and decreased “relaxed/still, agonistic, aggressive and abnormal behaviors” (Jacobsen et al., 2010). Indoors, capuchins at Rolling Hills Zoo spent the majority of their time moving back and forth across the exhibit seemingly without purpose. While pacing has been shown as a negative behavior in some species, for capuchins pacing was found to not be related with their “emotional state” (Pomerantz et al., 2012). Lastly, putting indoor blinds to hide and sleep behind may be beneficial for both lemurs and capuchins.

By taking time to monitor captive animal behavior, findings can be used to evaluate their environment. Improving captive settings may also involve looking at stressors which may be undetectable by “human caregivers” such as: “artificial lighting, exposure to loud or aversive sound, arousing odors, and uncomfortable temperatures or substrates” (Morgan and Tromborg, 2006). Although some sources of stress may be unknown, knowing the natural history of the species and “evaluation of all aspects of the captive setting” will help improve animal welfare (Morgan and Tromborg, 2006).

### Conclusion

The increase in the number of occurrences of foraging outdoors for capuchins shows that they need more opportunities for this behavior indoors. A greater number of occurrences of inactivity indoors show capuchins need additional stimuli and enrichment. Lemurs need additional stimuli indoors to encourage activity. For both lemurs and capuchins, additional areas indoors, out of view from staff and the public, could be built to provide secure sleep spaces.

Often facilities have a need to change an animal's environment throughout different times of the year and efforts should be made that these changes do not result in a decrease in species-typical behaviors. In an unnatural setting, exhibit modifications and enrichment can be provided to help facilitate expression of natural behaviors in a rate similar to that in a more natural setting. For lemurs and capuchins at Rolling Hills Zoo, a more behavior-targeted enrichment plan can be added to increase natural behaviors, particularly in their indoor housing.

### Acknowledgements

We would like to thank Kira Noda, relief keeper, for helping us survey behaviors. We would also like to thank Rolling Hills Zoo and our supervisors Brenda Gunder and Vickie Musselman for allowing us the time to work on this project and the support they provided. Thank you to Danelle Okeson, DVM for advice and support.

### Literature Cited

- Dishman, D.L., N.J. Karnovsky, and D.M. Thomson. 2009. Does simple feeding enrichment raise activity levels of captive ring-tailed lemurs (*Lemur catta*)? *Applied Animal Behaviour Science* 116(1):88-95.
- Ellwanger, N., and L. Gould. 2011. Variations in behavioral patterns between *Lemur catta* groups living in different forest types: implications for conservation. *Endangered Species Research* 14:259-270.
- Fragaszy, D. 2005. Capuchin Monkeys. *Enrichment for nonhuman primates*. Retrieved from <http://grants.nih.gov/grants/olaw/Capuchins.pdf>
- Jacobsen, K.R., L.F. Mikkelsen, and J. Hau. 2010. The effect of environmental enrichment on the behavior of captive tufted capuchin monkeys (*Cebus apella*). *Lab Animal* 39(9):269-277.
- Keith-Lucas, T., W.J. Frances, L. Keith-Lucas, and L.G. Vick. 1999. Changes in Behavior in Free-Ranging *Lemur catta*, Following Release in a Natural Habitat. *American Journal of Primatology* 47:15-28.
- Maloney, M.A., S.T. Meiers, J. White, and M.A. Romano. 2006. Effects of three food enrichment items on the behavior of black lemurs (*Eulemur macaco macaco*) and Ring-tail Lemurs (*Lemur catta*) at the Henson Robinson Zoo, Springfield, Illinois. *Journal of Applied Animal Behaviour Science* 9(2):111-127.
- Morgan, K.N., and C.T. Tromborg. 2007. Sources of stress in captivity. *Journal of Applied Animal Behaviour Science* 102:262-302.
- Pomerantz, O., J. Terkel, S.J. Suomi, and A. Paukner. 2012. Stereotypic head twirls, but not pacing, are related to a “pessimistic”-like judgement bias among captive tufted capuchins (*cebus apella*). *Animal Cognition* 15(4):689-698.
- Shire, T. 2012. Differences in behavior between captive and wild ring-tailed lemur (*Lemur catta*) populations: Implications for reintroduction and captive management. (Graduate thesis and dissertation, Iowa State University).

# Preventive Maintenance

Kathryn Juliano

American Association of Zoo Keepers - Safety Committee

## Introduction

Animal keepers often have nightmares about system failures and subsequent outcomes at work. Big cat keepers imagine tigers breaching containment barriers. Aquarists worry about losing electricity to life support systems in a room full of tropical tanks. Small mammal keepers fear animals left outside in inappropriate temperatures. However, all keepers have similar concerns about fires, animal escapes, limbs slammed in doors, and worse.

Yet, in all of this, there is one easy way for keepers to mitigate the risk that these worst-case scenarios will occur: preventive maintenance. This type of maintenance focuses on inspecting and servicing equipment to avoid malfunction; it can save time, money, and energy. Many facilities complete some level of preventive maintenance but may do so sporadically and without appropriate, detailed documentation. Creating and implementing a formal plan can seem mundane and perhaps unnecessary, but it could be the difference between life and death for both animals and zoo keepers.

Beyond animal safety and care, a preventive maintenance plan can reduce injury to keepers and prevent long-term health issues. Plans also have great benefits for the facility, including reduced damages and lowered expenses. It's often cheaper to prevent damage than repair damage; maintaining a lock following the manufacturer's recommendation is much cheaper than replacing a lock. A well-documented plan can help ensure Occupational Safety and Health Administration (OSHA) compliance and reduce stress before government or accreditation inspections. It is easy to create and implement a preventive maintenance plan and subsequently see the positive impact on facilities, keepers, and animals.

## Creating A Preventive Maintenance Plan

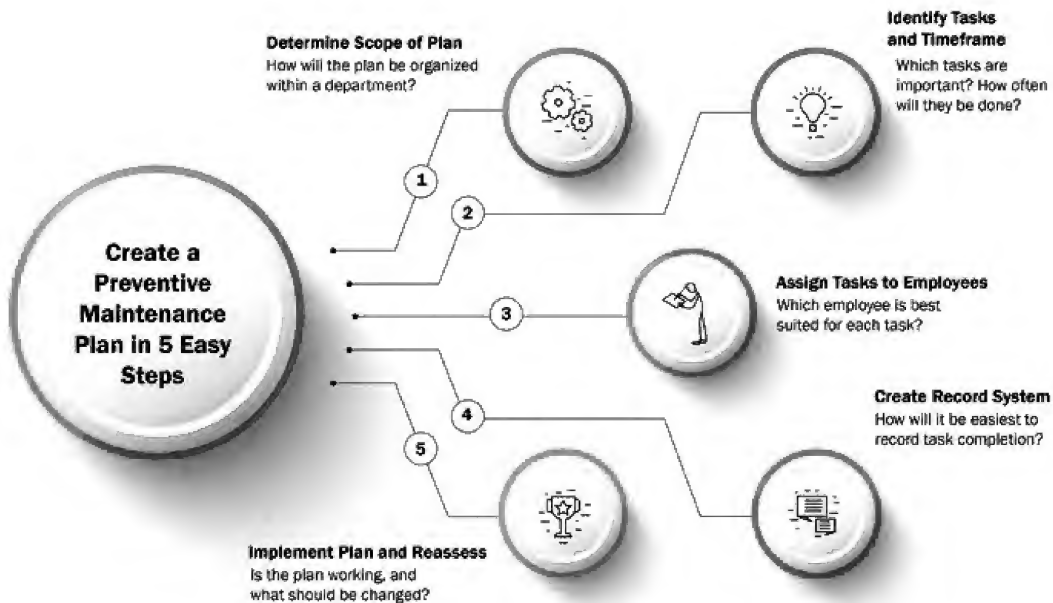
It only takes a few steps to create a preventive maintenance plan. First, in direct consultation with supervision, decide the scope of the plan within the facility. Second, create a list of preventive maintenance tasks following the manufacturer's recommendations and determine how frequently these tasks should be completed. Third, determine responsibilities for various tasks to employees within the unit or department. Fourth, create a record system that can be accessed and understood by everyone who will participate in the plan. Fifth, ensure proper instruction and training are received and begin completing the routine tasks. Evaluate and adjust the plan as needed.

To begin creating a preventive maintenance plan, first determine the scope and size of the plan. A plan may encompass an entire unit or department, or it could be organized by divisions within a section. Consider the size, organization, and staffing of the department and consult with the safety experts at the facility, too. Some zoos may have a safety specialist, safety committee, or maintenance department who could help organize, train, and implement preventive maintenance plans. Many departments already have a point person for safety who could start working on a plan.

Each plan should contain a list of maintenance tasks that will be completed on a regular basis. In order to select duties, think about an object or feature's role, risk, and implication. The role of the feature identifies how important the item is and how frequently it is used. Is it a shift door that is used every day to move primates, or is it a lock on a storage closet? Think about the risk of damage to the feature. Is the shift door fragile or durable? Is the lock to the storage closet exposed to the weather? Finally, consider the implication should the feature fail. If the shift door's cable snaps, could it potentially injure a primate? If the lock to the storage closet is stuck closed, will access to important capture items be blocked? Determining the role, risk, and implication of every item can help determine what tasks need to be included within the preventive maintenance plan, and how often the tasks should be performed.

Once a list of tasks is created within a plan, determine how frequently these tasks should be completed. Tasks could be executed every month, every six months, every year, or any time interval in between. It may be decided that some responsibilities are too important to be included in the preventive maintenance plan and must instead be completed every day. For example, many facilities would say that hotwire or other elements of primary containment must be checked every day. Make sure to follow recommended service intervals for certain equipment. Check with a manufacturer, consult OSHA resources, or look for a printed expiration date. Consider each object's role, risk, and implication, and think practically about the amount of time staff can utilize to determine how frequently each task will be completed.

After creating a list of tasks, responsibility must be assigned for each duty. When allocating preventive maintenance tasks, it's best to evenly divide tasks to ensure compliance and prevent employees



from becoming overwhelmed. Some duties are best allocated to employees who work in an area most frequently, especially if these responsibilities must be completed within animal areas. Other tasks are best appointed to shift keepers or employees who are in the area less frequently. These staff may be able to see the area and its equipment with a fresh perspective - noticing changes over a period of time that were gradual and subsequently unnoticed by daily staff - or they can have a narrow focus on one category of responsibilities across departments, like checking fire extinguishers. Get everyone in the unit involved so that staff are all accountable and able to take pride in their area's upkeep.

Finally, there needs to be an easy way to keep track of what tasks have been completed. Each plan should have a record system that allows for easy access by multiple people. Digital copies can be stored on a facility's computer network or within an online document-hosting site. Some people may prefer a paper record system that is kept in a central location. Information in paper records can then be uploaded to a digital copy for easy reference. Whichever record system is selected, records should be kept for at least five years as proof of maintenance for inspections. When recording the locations of objects or tasks in the plan, make sure that all employees understand the names of different locations. Include a key if abbreviations are used and include a map or floor plan if available. Using names for areas based off of animals should be avoided, as the facility's collection can change. Once a task is completed, each individual should initial or sign off in the records to foster accountability and ensure compliance.

#### Common Preventive Maintenance Tasks

Some common preventive maintenance tasks have been included here. Most of these tasks should be required in any plan, but each

facility and department is different. Consider the role, risk, and implication of these features within the facility when tasks are added to the plan.

Shift doors can cause great injury to animals and keepers if they fail, and it is recommended that they be tested at least once a month. There are many different types of shift doors, so be sure to consider what maintenance is required for the facility or building. Most doors would benefit from frequent greasing with a lubricant or a dry graphite spray. Check with the door's manufacturer to see which type of lubricant is appropriate. Some doors function with a rope or cable. Regularly check for tears, snags, or deterioration and record any possible damages the moment they are seen. Hydraulic doors must be checked regularly without animals present and should be lubricated or maintained following the manufacturer's instructions. Some shift doors may be so important that they need to be checked more frequently than once a month. Think carefully about the door's role, risk, and implication, and discuss the issue with coworkers. Remember that it may only take a few minutes to properly check a door, and the benefit of a check could be much greater than the implication if the door should fail.

Hotwire should be checked daily to ensure that it is functioning correctly. However, a more thorough check of any hotwire or electric fence can be completed every month. Look for plant growth or other items that could get too close to the hotwire and trim any tree or bush limbs that could snap off in a storm. Look for breaks or places of weakness. This task may be good for someone who is not in the area frequently and could provide a fresh perspective. Again, make sure to consider the risk, role, and implication of each set of hotwire or electric fence within the facility.

Object/ Feature	Tasks	Recommended Frequency
Shift Doors	Grease or lubricate doors, test function, look for breaks in cables or ropes	At least once a month
Hotwire/ Electric Fence	Look for breaks or places of weakness, look for objects that could disrupt hotwire	At least once a month
Locks	Grease or lubricate, test function	Once a month- every six months
Animal Escape Equipment	Inspect equipment for damage or disrepair, ensure all equipment is present	Every three months- every six months
Fire Alarms	Test alarm for proper function	Every six months
Fire Extinguishers/ CO2/ Pepper Spray	Check pressure gauges and that pins are in place, ensure proper storage, check if expired	Once a month- every six months
Eyewash Station	Check that water flows strongly, drains correctly, and water runs clear	Once a month
Hazardous Materials	Look for leaks, make sure bottles are properly labeled, keep areas clear of clutter	Every six months
Heaters and Fans	Dust as needed, look for damage to power cords, change filters as needed	Every three months- seasonally
Electrical Cords	Ensure all cords are properly stored and used	Every six months
First Aid Kits	Replace used supplies, replace kit if expired	Once a month
Radios	Check proper function, update inventory	Every six months
Vehicles	Follow owner manual's instructions, inspect tires for damage, check and replace fluids	Once a month- every three months

Locks are important to check and maintain, but not all locks need to be checked on a monthly basis. Some locks could affect animal welfare if they fail, but other locks will just inconvenience keepers. Check locks at different frequencies when it seems appropriate. When checking a lock, bring a can of lubricant or dry graphite spray, depending on the lock manufacturer's suggestion. Lubricate any area that sticks on the lock, including the locking mechanism, key opening, or openings for the shackle. Open and close the lock several times to check that it operates smoothly before placing it back in its proper location.

Take some time every month to ensure that animal escape stations or equipment are properly maintained. If there is a designated station or area for equipment, make sure it is clearly labeled and appropriately stocked. Check that all tools are in good condition. Look for holes or tears in nets, ensure that doors and tops are on critter carriers, and make sure that all bite gloves are in good condition. Some units have additional sets of equipment near animal enclosures in the chance that a person breaches animal containment barriers. Make sure to check this equipment well. The box or kit may be labelled or discreet, depending on the facility's preference, but it should always be free of clutter and easily accessible. Check that ladders function properly and haven't been

affected by the elements, and that rope or cord ladders have not been damaged by pests. Replace any missing or damaged items. Checking that animal escape equipment is functioning properly could only take a few minutes and drastically change the outcome of an animal emergency.

Fire alarms and extinguishers need to be checked regularly. It's recommended that fire alarms are tested at least every six months and batteries are replaced every year. Fire extinguishers should be inspected every month by an individual trained in extinguisher inspection. In order to ensure that every extinguisher is checked, record the locations of every canister and label each canister at its storage location. Fire extinguishers should be stored up off of the ground. Ensure that there is no clutter around the extinguishers and that they are easily accessible. When checking the extinguisher, use the gauge on the canister to ensure that the pressure within the extinguisher is at the appropriate level and the canister is not past its expiration date. Most extinguishers have a tag on the canister that allows the employee to record inspections.

Check that other safety equipment, like pepper spray or CO2 canisters, is properly stored as well. The locations of these items should also be listed in the record system, and each canister should be labeled within the facility. CO2 canisters should be stored up off of the ground. Both CO2 canisters and pepper spray should have a pin blocking the release mechanism. Check the bottle or manufacturer for recommendations on replacement times; most canisters will need to be replaced every few years.

Eyewash stations have to be inspected once a month. Make sure that the water flows strongly out of both faucets, the water drains out appropriately, and that the water runs clear from the faucets. If the eyewash station runs off of a bottle, check the bottle's expiration date to make sure it isn't expired. Record the location of every eyewash station in the plan and label each station within the facility. Eyewash stations also have tags that allow the employee to record inspections on the device itself.

Hazardous materials, such as cleaners, should be checked at least every six months. Look for signs of leaks or spills, and confirm that each bottle is properly labeled. Keep a list of materials and their locations along with a Safety Data Sheet (abbreviated as "SDS" and previously known as "Material Safety Data Sheets" or "MSDS") to ensure OSHA compliance. Make sure that SDSs are kept both near the hazardous materials as well as with the record system. Keep storage cabinets and areas clean and keep openings or doorways free of clutter.

Check heaters and fans for proper guarding and inspect their power cords. Some equipment may need to be dusted to prevent fires, while other equipment may need to be checked seasonally depending on its use. Check that power cords are intact and haven't been chewed on by mice or damaged in any other way. On dust collecting equipment, check vents and filters, and change filters according to the manufacturer's instructions.

Check regularly for poorly placed electrical cords that can create tripping hazards and electrical problems. Ensure that each electrical cord has an intact grounding device and is rated for either wet locations or outdoor use, depending upon placement. Ensure that cords are properly stored or are placed out of pathways. Remove extension cords or power strips if they are improperly used. Make

## Preventive Maintenance Plan Examples:

An example of part of a preventive maintenance plan for 2 outdoor yards.

	Jan 2018		Feb 2018		Mar 2018	
Heater Checks						
Yard 1	1/5	KJ	2/8	KJ	3/20	KJ
Yard 2	1/12	DD	2/4	DD	3/6	DD
Clear Vegetation from Hotwire						
Yard 1	1/8	KJ	2/10	KJ	3/22	KJ
Yard 2	1/12	DD	2/10	DD	3/6	DD
Check and Lubricate Locks						
Yard 1	1/5	KJ	2/15	KJ	3/22	KJ
Yard 2	1/17	DD	2/12	DD	3/11	DD

An example of a record of fire extinguisher checks completed by one person. Note that no areas are identified with animal names.

Extinguisher Number	Location	Bar code #	Jan	Feb	Mar
1	Blue Line	100456	16-Jan	19-Feb	4-Mar
2	Blue Line Office	100459	16-Jan	19-Feb	4-Mar
3	Kitchen	100611	16-Jan	19-Feb	4-Mar
4	Center of Building	100612	16-Jan	19-Feb	4-Mar
5	Yellow Line	100614	16-Jan	19-Feb	4-Mar
6	White Line	100616	16-Jan	19-Feb	4-Mar
7	Yellow Mech. Room	110620	16-Jan	19-Feb	4-Mar
8	White Mech. Room	100458	16-Jan	19-Feb	4-Mar
9	Yard 97 Barn	100619	29-Jan	20-Feb	4-Mar

sure to check areas that don't receive significant foot traffic, and look at equipment that is used seasonally, too. This may be a great task for someone who isn't as familiar with the area and has a fresh set of eyes.

First aid kits should be checked every thirty days. Record the location of every kit and label the kits within the facility. Check that kits have all of the necessary supplies, and replace materials that have been used. Some kits have expiration dates. Make sure kits are replaced as needed and keep a record of when the kits were replaced.

It's important to maintain handheld radios. Work with upper management to keep a list of radios, their serial numbers, and if they are assigned to a staff member. Record damage or faulty function and submit the unit for immediate evaluation and/or repair to supervision. Make sure that batteries are charging, that the charging stations work correctly.

Vehicle maintenance can be very complex, and the owner manual for each vehicle should be consulted first. As a minimum, inspect the vehicle for damage and wear. Check the fluid levels and regularly change any oil according to the owner manual's recommendations. Inspect the tires for damage, look at the tire treads for excessive wear, and check the tire pressure. Ensure that the vehicle storage area and the vehicle are free of clutter and easily accessible. A separate set of records should be kept for each vehicle to record damages, use, and repairs.

## Implementing a Preventive Maintenance Plan

Identifying tasks, determining their frequency, and ensuring tasks are assigned to different employees will lead to completing the tasks regularly. The first set of checks can take a long time to finish, but duties will get easier as they are regularly completed. Make sure to continually evaluate a plan's effectiveness and change aspects of the plan as needed. A great plan may switch responsibilities between employees every year to avoid complacency. Exchange information and plans throughout the facility to ensure that all tasks are completed and to share ideas about how to best implement preventive maintenance plans.

Preventive maintenance can seem dull and unnecessary, but it can save time, money, and lives. Just a few hours a month could change the outcomes of emergencies like fires, animal escapes, and natural disasters. Preventive maintenance is better for the keeper and the facility and, most importantly, the animals. Start working on a plan now!

## References

- AZA Special Committee on Safety. 2015. Zoo & Aquarium Safety: Example Practices. Association of Zoos & Aquariums. Accessed 13 Feb 2018. [https://www.aza.org/assets/2332/safety\\_example\\_practices\\_for\\_aquariums\\_zoos\\_2015.pdf](https://www.aza.org/assets/2332/safety_example_practices_for_aquariums_zoos_2015.pdf).
- Occupational Safety and Health Administration. 2016. OSHA Safety and Health Program Management Guidelines. Accessed 13 Feb 2018. [www.osha.gov/shpguidelines](http://www.osha.gov/shpguidelines).
- Occupational Safety and Health Administration. 2016. Recommended Practices for Safety and Health Programs. OSHA 3885. Accessed 13 Feb 2018. [https://www.osha.gov/shpguidelines/docs/OSHA\\_SHP\\_Recommended\\_Practices.pdf](https://www.osha.gov/shpguidelines/docs/OSHA_SHP_Recommended_Practices.pdf).
- Occupational Safety and Health Administration. 2012. OSHA Brief - Hazard Communication Standard: Safety Data Sheets. DSG BR-3514 2/2012. Accessed 13 Feb 2018. <https://www.osha.gov/Publications/OSHA3514.pdf>

## June is National Safety Month

AAZK's Safety Committee is dedicated to developing and exchanging resources focused on safety and health in zoos and aquariums. We create workshops and certificate courses for national AAZK conferences and share information through multiple channels, including Animal Keeper's Forum. June is National Safety Month and we're excited to present this article that focuses not only on animal safety, but overall workplace safety. Stay safe this June and look for more of our safety information on AAZK social media.

# Comparing Responsiveness of Nocturnal and Diurnal Primates to Different Sensory Enrichment Conditions

Chris McGovern, Student  
Dr. Cheryl Frederick, Advisor  
Dr. Jennifer Clarke, Advisor  
Unity College, Unity, Maine

## Abstract

Sensory enrichment has been used to improve the welfare of nocturnal and diurnal primates in captivity. This study looked at whether nocturnal and diurnal primate species would respond differently to four sensory enrichment conditions based on the differences in their natural history. Subjects were two nocturnal primates, pygmy slow lorises and douroucoulis monkeys, and two diurnal primates, golden lion tamarin and black and white ruffed lemur. In general, diurnal primates were found to respond more to the olfactory, auditory, and tactile enrichment than nocturnal primates. The nocturnal primates were found to be more responsive to visual enrichment. These results may be used to suggest what types of sensory enrichment could be most effective for these species.

## Introduction

Enrichment comes in various forms with the goals of increasing behavioral diversity, reducing abnormal behaviors, increasing the number of normal behavioral patterns, increasing the proper use of the environment, and promoting the ability to interact with a changing environment (Rapaport, 1998; Young, 2003; Kleiman, 2010; Rees, 2011; Hosey, 2013). There are four main categories of enrichment provided to animals: physical, cognitive, social, and sensory. Sensory enrichment is the addition of sensory stimuli to an animal's enclosure (Rees, 2013; Hosey,

2013). Examples of sensory enrichment include visual, auditory, olfactory, and tactile forms. However, compared to other types of enrichment, sensory enrichment has not been as well studied (Trevino et al., 2007; Robbins et al., 2014). Clark et al. (2011) found that sensory enrichment could positively alter the behavior of sloths, armadillos, and bush babies by increasing their activity levels. Still other studies have shown that primate welfare improves with sensory enrichment. Auditory and olfactory forms of enrichment increased the welfare of gorillas by decreasing their stereotypical behaviors (Rees, 2011; Robbins et al., 2014).

Institutions accredited by the Association of Zoos and Aquariums are required to have an enrichment program not only for primates but for all animals in their care (Kleiman, 2010; Rees, 2011). With enrichment being required at these institutions, many studies conducted in zoological parks now involve enrichment. Enrichment is the second most studied subject in zoological institutions (Hosey, 2013) and primates make up a majority of studies on enrichment for mammals (Kleiman, 2010).

In captivity, primates have shown differences in behavior compared to their counterparts in the wild. Captive black-and-white ruffed lemurs spend less time foraging and feeding than their wild counterparts (Kerridge, 1996; Britt, 1998).

Britt et al. (1998) reported that these lemurs spent three to nine percent less time foraging than their wild counterparts. This could be due to easier access to food in captivity than in the wild. Easier access in finding food puts less stress on the primate but there are more stresses on primates than just food acquisition. Even with easier access to food, you are more likely to see higher stressed individuals in captivity than in the wild. Armstrong et al. (2013) looked at hormone levels and found that tamarins on exhibit exhibited higher stress levels when compared with a pair held off exhibit. One way to decrease stress and improve the welfare of primates in captivity is to supply enrichment (Bloomsmith, 1991; Young, 2003; Rees, 2011; Brooker, 2016).

Insights into the implications of sensory and behavioral differences found in nocturnal and diurnal primates have successfully been applied to the husbandry of primates in captivity. Clark et al. (2011) examined how sensory enrichment can improve nocturnal animals' husbandry while Robbins et al. (2014) used sensory enrichment to improve the husbandry of diurnal animals. This approach makes a lot of sense when considering all the potential impacts activity cycle has on their behaviors and abilities. Nocturnal prosimians are normally solitary while diurnal prosimians live in pairs or groups (Fitch-Snyder, 2003; Vaughan, 2015). Diurnal species of New World primates

are dichromatic (males) and trichromatic (females) (Jacobs et al., 1996; Jacobs et al., 2001). The nocturnal New World primates, douroucoul monkeys (*Aotus trivirgatus*), are monochromatic because of the lack of short-wavelength sensitive cones that were evolved for mammalian color vision (Jacobs, 1993). The diurnal New World primates rely more on visual sense than the nocturnal New World primates. Nocturnal species use olfactory senses as their main communication while diurnal primates, like the ring-tail lemur (*Lemur catta*), use a mixture of olfactory, auditory, and visual sense in communication (Vaughan, 2015).

The goal of the present study on primate enrichment was to investigate the differences and/or similarities in the responsiveness to various sensory enrichment between nocturnal and diurnal primate species. Understanding the natural history of primate species should give us a better understanding of what types of enrichment will be most effective for a particular species. There are many potential forms of sensory enrichment to give to primates but knowing the differences in primate sensory abilities that are shaped by natural history factors such

as activity cycle could be key to having more impactful enrichment.

We anticipate that nocturnal and diurnal primate species will respond strongly to the enrichment that stimulates their ability to perform natural behaviors. The douroucoul monkeys used their olfactory senses to locate food while diurnal tamarins located their food visually (Bicca-Marques et al., 2004). Thus, it is predicted that diurnal species will react more to visual enrichment while nocturnal primates will be more responsive to olfactory enrichment. In studies looking at vocalizations, nocturnal prosimians were only recorded to vocalize twice outside of breeding season (Braune et al, 2005). Similarly, douroucoul monkeys were identified to have only five distinct types of calls (Kantha et al., 2009). *Lorisidae* vocalizations are limited and seldom heard while black and white ruffed lemurs have an extensive vocal repertoire (Mittermeier et al., 2013). Diurnal species should respond more strongly to auditory sensory enrichment than nocturnal primates because of the variation in modes of communication. Diurnal species can be found in groups ranging from small family groups to groups of up to thirty individuals

(Mittermeier et al., 2013). Nocturnal species live in much smaller groups. Most nocturnal primate species are solitary but some live in small family groups (Mittermeier et al., 2013). Finally, diurnal primate species should respond more to tactile enrichment than nocturnal species because of their differences in sociality.

## Methods

### Study Subjects/Location

Four primate species (black-and-white ruffed lemurs (*Varecia variegata*) (BWRL), pygmy slow lorises (*Nycticebus pygmaeus*) (PSL), douroucoul monkeys (*Aotus trivirgatus*) (DM), and golden-lion tamarins (*Leontopithecus rosalia*) (GLT) housed at Capron Park Zoo in Attleboro, Massachusetts USA were observed in this study. Each species was housed in a 1.1 male, female pair. All animals were adult and were born between April 1998 and April 2005. Capron Park Zoo houses their two-nocturnal species, DM and PSL, in a nocturnal house that is on a reverse light schedule. The diurnal species, BWRL and GLT, spend seven months in an outdoor enclosure and the other five months in winter holding enclosures. Because this

## Methods

**Table 1:** Ethogram used in the study

Behavior Category	Behaviors	Description	Code of Ethogram
Out of Sight	Out of Sight	Animal is not visible on exhibit or it cannot be determined what it is the animal is doing	OS
	Hide	Animal retreats to nest box	H
Ignore (IGN)	No Response	Animal ignores enrichment and does not glance at it	NR
	No Interaction	Animal glances at enrichment but does not touch it	NI
Agonistic (AGO)	Displacement	Animal takes up the position or possession of an item previously held by another animal	D
	Take	Animal scent marks the enrichment item	T
	Aggression	Animal reacts violently towards conspecifics	A
Sociality (SOC)	Vocalization	Animal produces sounds	V
	Interaction with Another Species	Animal interacts with other species in or around the enclosure	IAS
	Other	Eating/Foraging, Drinking, Grooming, Inactivity (5 seconds or more)	O
Exploratory (EXP)	Olfactory Response	Animal smells enrichment	OR
	Auditory Enrichment Response	Animal(s) orient to the auditory enrichment with vocalizations and/or actively try to find source of sounds	AER
	Tactile Response	Animal touches/picks up enrichment	TR
	Olfactory Response	Animal smells or scent marks enrichment	OR
Running Away	Running Away	One animal is running away from the other animal or visual enrichment	RA
Locomotion	Locomotion	Animal is moving around exhibit	LOC
Scent Marking	Scent Marking	Animal marks territory, uses olfactory senses to identify marked location	SM
Chase	Chase	Animal(s) follow laser pointer around exhibit or conspecifics (play)	CH



study occurred during December 2016, the diurnal species were in their winter holding.

The daily routine care for these four species was interrupted minimally during this study. All species' enclosures were cleaned before the sensory trials were conducted. All observations were conducted between 10:00 a.m. and 3:15 p.m. The morning and afternoon feedings were not affected. The morning feedings were done before 9:30 a.m. while the afternoon feedings were provided after 3:30 p.m.

### Ethogram

An ethogram consists of behaviors listed and described for a species that may exhibit them (Kleiman, 2010; Rees, 2011; Hosey, 2013; Rees, 2013). This study used an ethogram that listed eighteen behaviors, the definition of those behaviors, and the abbreviation for each behavior which can be found in Table 1. This table also indicates how the eighteen behaviors were combined to create larger behavioral categories.

### Observations

Behaviors were measured for thirty-minute observation periods, with each period split into six, five-minute intervals, using continuous sampling. Each species was observed fifteen times over the course of the study. Observation hours were split into the half hour prior to presentation of enrichment, representing a control period, followed by the half hour in which the enrichment was presented. Data were collected over fifteen days between December 2016 and January 2017. All four species were observed each day for an hour at a time. Observations were made four times during the week with each enrichment item being used once per week. All species received the same enrichment on the same day. Each enrichment device trial occurred four times except the tactile enrichment, which occurred only three times, due to a weather related closure.

### Enrichment Devices

Four different sensory enrichment devices, approved by CPZ's animal management staff, were used in these trials: olfactory, auditory, visual, and tactile examples were offered to stimulate the senses. The olfactory enrichment involved scent sticks that were attached (zip-tied) to branches within each exhibit. The scent stick was soaked in the fecal matter of red ruffed lemurs (*Varecia rebra*). Two scent sticks were placed in the same spot of the exhibit each time. Auditory enrichment was classical music played

through a portable speaker at the exhibit fence line. The visual enrichment was a battery-operated automatic laser pointer (PetSafe Frolicat Bolt Interactive Laser Pet Toy). The laser pointer was placed outside the exhibit pointed towards the branches in the enclosure as each species is arboreal. Lastly, the tactile enrichment was a container filled with leaves that was intended to hide food (grapes) hung on a branch in the enclosure. The same size container was used for the pygmy slow loris, douroucouli monkeys, and golden-lion tamarins. Since the black and white ruffed lemurs are larger primates, their tactile enrichment container was larger.

### Data Analysis

Behavioral data were split into control and experimental trial conditions. A non-parametric sign test was performed on behaviors for each species and enrichment type to examine if there were differences between the control and experimental periods. Behaviors were then grouped into more-encompassing categories; *Locomotion*, *Scent Marking*, and *Sociality*, and these underwent further statistical analysis. Statistical analyses were done using the JMP program to conduct one-way and two-way ANOVAs. The independent variables examined were primate species and/or enrichment condition and the dependent variable was the behavior category of interest. Significance levels for all tests were set to  $\alpha < 0.05$  and all means presented are mean  $\pm$  SE, unless otherwise stated.

### Results

A total of 2,302, 916, 640, and 837 behaviors were observed for GLT, DM, PSL, and BWRL during the control period, and 2,422, 1,267, 698, and 1,265 during the enrichment trials, for each of the primate species respectively. Animals were out of view 5.6% - 32.1% of the time (see Table 2). The PSL spent the most time out of view overall with the three highest percentages of *Out of Sight* (25.2%, 31.8%, and 32.1%) while the BWRL spent the least amount of time out of view with all percentages of *Out of Sight* less than 9%. During the enrichment trials, the primates only failed to react or interact to the enrichment presented a small portion of the time, most notable was the visual enrichment having the highest *Ignore* percentage ranging from 0% (seen in all species) - 25.3% (PSL).

Sign tests examined whether or not significant differences were seen between the control and enrichment periods under

each enrichment condition for the four species (Table 3). DM were the most affected by the enrichment types offered. They showed a significant difference between the control and experimental condition for Olfactory ( $p = 0.01$ ) and Tactile ( $p = 0.05$ ) enrichment and a nearly significant difference for Auditory enrichment ( $p = 0.09$ ). The nature of the difference was that all behaviors increased or stayed the same (0 = no difference) under experimental conditions except for *Agonistic* which decreased under the Auditory enrichment condition and *Out of Sight* which decreased under the Tactile condition (Figure 1a). BWRL showed a significant difference between the control and experimental condition for Olfactory enrichment ( $p = 0.01$ ; Table 3). The frequency of all behaviors, except *Running Away* and *Chase* which were 0 = no difference, increased during Olfactory enrichment; especially *Social* behavior which had the greatest magnitude in difference (Figure 1b).

The predictions that nocturnal primates would behaviorally respond more strongly to Olfactory than to Visual enrichment, and that diurnal primates would respond more strongly to Visual rather than to Olfactory enrichment, were tested in a series of two-way ANOVAs. For the behavior category *Scent Marking*, there was a significant difference between primate species ( $F_3 = 14.3309$ ,  $p < 0.0001$ ), but there was no significant difference between enrichment condition ( $F_1 = .2869$ ,  $p = 0.5925$ ) or enrichment condition\*primate species ( $F_3 = 1.0836$ ,  $p = 0.3559$ ). The BWRL showed the highest average for *Scent Marking* of all species in both the Olfactory enrichment (mean =  $1.167 \pm 0.15$ ; Figure 2) and Visual enrichment conditions (mean =  $1.208 \pm 0.15$ ; Figure 3).

In contrast, the behavior category *Sociality* was significantly different between primate species ( $F_3 = 137.6826$ ,  $p < 0.0001$ ) and enrichment condition ( $F_1 = 11.1147$ ,  $p < 0.0009$ ) and an interaction between primate species and condition was found ( $F_3 = 5.7419$ ,  $p < 0.0008$ ). Overall averages were higher for the Olfactory condition (mean =  $6.58 \pm 0.29$ ; Figure 2) than for the Visual condition (mean =  $5.22 \pm 0.29$ ; Figure 2); only PSL showed no difference between enrichment conditions. GLTs exhibited the most social behavior (mean =  $12.77 \pm 0.4$ ), and this was highest during the Olfactory condition (mean =  $14.87 \pm 0.57$ ; Figure 2 vs. Figure 3).

## Results

**Table 2.** Percentage Out of Sight (OS) and percentage of time the enrichment condition was Ignored (IG) from GLT, DM, PSL, and BWRL

	Auditory		Olfactory		Visual		Tactile	
	Control	Experiment	Control	Experiment	Control	Experiment	Control	Experiment
<b>GLT</b>								
OS	19.6%	21%	18.9%	16.8%	18.9%	20.8%	22.5%	18%
IG	-	0.1%	-	4.3%	-	6.1%	-	0
<b>DM</b>								
OS	15.1%	14.6%	12.4%	8.4%	10.6%	9.3%	25.2%	8%
IG	-	0	-	6.2%	-	20.6%	-	3.2%
<b>PSL</b>								
OS	31.8%	32.1%	19%	22.8%	20.2%	17.8%	25.2%	15.6%
IG	-	0	-	4.1%	-	25.3%	-	3.7%
<b>BWRL</b>								
OS	8.3%	7.1%	5.6%	5.2%	6.5%	4.5%	7.9%	2.2%
IG	-	0	-	1%	-	15.5%	-	0.3%



	AUD	OLF	TASTS	VISUAL
PSL	0.27	0.31	0.22	0.27
BWRL	0.27	0.01	0.16	0.22
GLT	0.16	0.27	0.31	0.25
DM	0.09	0.01	0.05	0.11

**Table 3.** (left) Sign Statistic p-value results examining the difference between control and enrichment conditions for behaviors under all four enrichment conditions for each species. Significant ( $p < .05$ ) or nearly significant differences are bolded.



Under the category, *Locomotion* there was a significant difference between primate species ( $F_3=59.66$ ,  $p<0.0001$ ) and condition\*primate species ( $F_3=3.2789$ ,  $p=0.0211$ ), but there was no significant difference between conditions ( $F_1=4.374$ ,  $p=0.5088$ ; Olfactory mean =  $4.9 \pm 0.2$  vs. Visual mean =  $4.7 \pm 0.2$ ). GLT had the highest average (mean= $7.8 \pm 0.28$ ), the next highest was the DM (mean= $4.8 \pm 0.28$ ). PSL and DM both had a slight decrease in *Locomotion* during the Visual enrichment condition (see Figure 2 vs. Figure 3).

The prediction that diurnal primates will be more responsive to Auditory enrichment than nocturnal primates was examined through testing with one-way ANOVAs. With Auditory enrichment, there was a significant difference between primate species in *Scent Marking* ( $F_3=2.8853$ ,  $p=0.0399$ ), *Sociality* ( $F_3=40.5635$ ,  $p<0.0001$ ), and *Locomotion* ( $F_3=20.9281$ ,  $p<0.0001$ ; Figure 4). A clear trend was observed with diurnal species having greater responsiveness to the Auditory enrichment than the nocturnal species (Figure 4). GLT and BWRL had a

higher mean frequency (GLT= $0.7917 \pm 0.22$  SE, BWRL= $.8333 \pm 0.22$  SE) for *Scent Marking* than the nocturnal PSL and DM (PSL =  $0.125 \pm 0.22$  SE, DM= $0.2917 \pm 0.22$  SE). GLT and DM also showed higher mean frequencies in *Locomotion* (GLT= $7.0833 \pm 0.54$ , DM= $5.375 \pm 0.54$ ) than the PSL and BWRL (PSL =  $1.5417 \pm 0.54$ , BWRL= $2.9167 \pm 0.54$ ). Lastly in *Sociality*, GLT and BWRL (GLT= $10.5 \pm 0.62$  SE, BWRL =  $4.8333 \pm 0.62$  SE) had a significantly higher mean frequency than PSL and DM (PSL =  $1.1667 \pm 0.62$  SE, DM= $3.9167 \pm 0.62$  SE).

The prediction that diurnal primates will be more responsive to Tactile enrichment than nocturnal primates was examined through testing with one-way ANOVAs. Tactile enrichment showed a significant difference between primate species in *Sociality* ( $F_3=18.7603$ ,  $p<0.0001$ ) and *Locomotion* ( $F_3=10.8204$ ,  $p<0.0001$ ) but there was no significant difference shown in *Scent Marking* ( $F_3=1.5435$ ,  $p=0.2112$ ; Figure 5). A slight trend was observed for diurnal species having greater responsiveness to the Tactile enrichment than the nocturnal species in two of the

three behavior categories (Figure 5). GLT and BWRL showed higher mean frequencies in *Scent Marking* (GLT= $.8333 \pm 0.22$ , BWRL =  $0.72222 \pm 0.54$ ) than the PSL and DM (PSL =  $0.5 \pm 0.22$ , DM= $0.2222 \pm 0.22$ ). GLT and BWRL (GLT= $9 \pm 0.81$  SE, BWRL =  $7.7778 \pm 0.81$  SE) had higher mean frequencies than PSL and DM (PSL =  $1.2222 \pm 0.81$  SE, DM =  $4.3333 \pm 0.81$  SE) in *Sociality*. Lastly, GLT and BWRL had higher mean frequencies (GLT= $8 \pm 0.59$  SE, BWRL =  $5.0556 \pm 0.59$  SE) for *Locomotion* than the nocturnal PSL and DM (PSL =  $3.2778 \pm 0.59$  SE, DM= $5.5 \pm 0.59$  SE).

## Discussion

Sensory enrichment has been shown to reduce stereotypes and increase species-typical behaviors in captive animals (Trevino et al., 2007; Wells and Irwin, 2008; Clark et al., 2012; Brooker, 2016). This study was conducted to examine the effects of sensory enrichment on nocturnal and diurnal primates in order to determine if sensory enrichment elicits different responsiveness from primates based on natural history factors (i.e. differing activity cycles). The results suggest that there is a

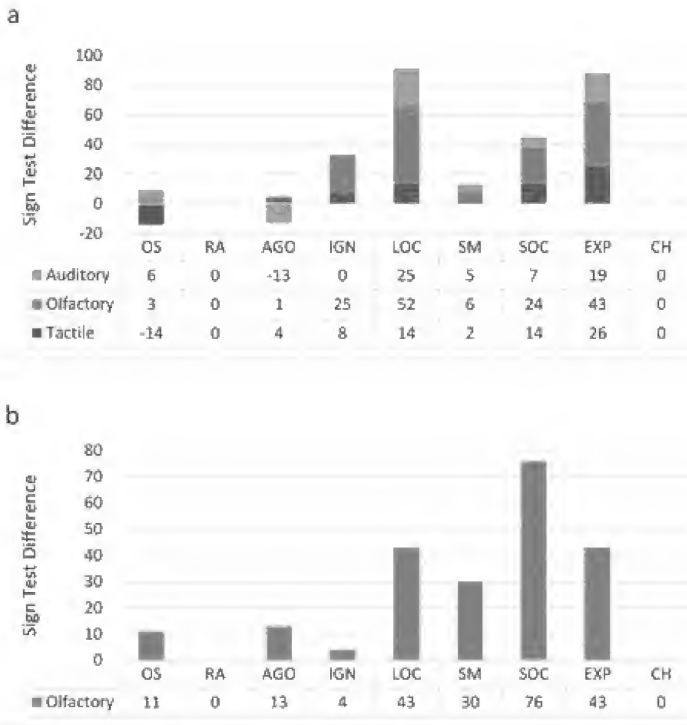


Figure 1. (a) The difference in frequency of occurrence (0 = no difference, negative numbers indicate a decrease) between control and enrichment conditions for DM under the auditory, olfactory and tactile enrichment conditions. (b) Sign difference between control and enrichment condition for BWRL under the olfactory enrichment condition.

clear difference in responsiveness between nocturnal (PSL and DM) and diurnal primates (FLT and BWRL) in some of the sensory enrichment conditions while other conditions produced little or no behavioral difference to the sensory enrichment provided.

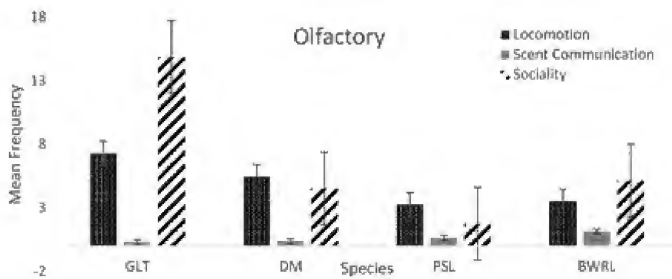
It was predicted that nocturnal primates would respond more strongly to Olfactory than Visual enrichment, and that conversely diurnal primates would respond more strongly to Visual rather than Olfactory enrichment. This prediction was posited because diurnal primates visually locate food while nocturnal primates use their olfactory sense to find food (Bicca-Marques et al., 2004). When comparing the control period to the enrichment trial period data showed that DM responded with increased active, social and exploratory behaviors and decreases in being out of view and agonistic behaviors to all forms of

enrichment except the Visual form offered. However, when considering the strength of reactions during the experimental period of one enrichment type versus another we see the opposite effect. PSL and DM reacted more to Visual enrichment than Olfactory enrichment while the GLT And BWRL were more responsive to Olfactory enrichment than Visual enrichment. Similarly, the BWRL showed the strongest response to Olfactory enrichment when comparing the control and experimental enrichment conditions. The GLT's spent more time *Out of Sight* during the Visual enrichment condition and the PSL's spent more time *Out of Sight* during the Olfactory enrichment condition. There was no difference between enrichment conditions in the two-way ANOVA analysis. Therefore, based off these results Olfactory enrichment may be more effective with diurnal species and Visual enrichment could be more effective for nocturnal species.

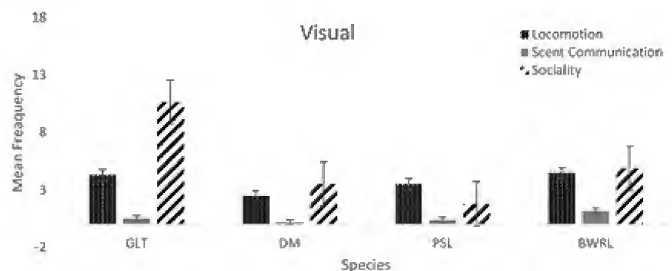
The second prediction that diurnal primates would more responsive to Auditory enrichment than nocturnal primates was supported. Auditory enrichment was shown to increase the welfare of gorillas, a diurnal species, by decreasing the stereotypical behaviors performed by the gorillas (Rees, 2011; Robbins et al., 2014). Clark and Melfi (2011) found that bush babies, a nocturnal primate, decreased species-typical behaviors and increased hiding behaviors when exposed to auditory enrichment (rainforest sounds). GLT and BWRL showed greater responsiveness than PSL and DM. Both PSL and DM spent the most time *Out of Sight* during the Auditory enrichment condition compared to the other enrichment conditions. Clark and Melfi (2011) found that bush babies produced negative reactions to auditory enrichment, potentially decreasing their welfare. Although this study cannot determine if the Auditory enrichment provided in this experiment decreased the welfare of the PSL or DM, it did not increase species-typical behaviors.

Lastly, diurnal primates were predicted to be more responsive to Tactile enrichment than nocturnal primates. This prediction was slightly supported with two of the three behaviors being exhibited more strongly in the diurnal species. Both *Sociality* and *Locomotion* increased during Tactile enrichment for GLT And BWRL, but not for PSL and DM. These results suggest that tactile enrichment is better suited for diurnal primates than nocturnal primates. It is worth noting that when comparing the control condition to the experimental conditions, DM responded more than all other species in the study, and they responded very positively to olfactory, tactile and auditory forms of enrichments. We hope that this paper encourages more varied sensory enrichment approaches for this species.

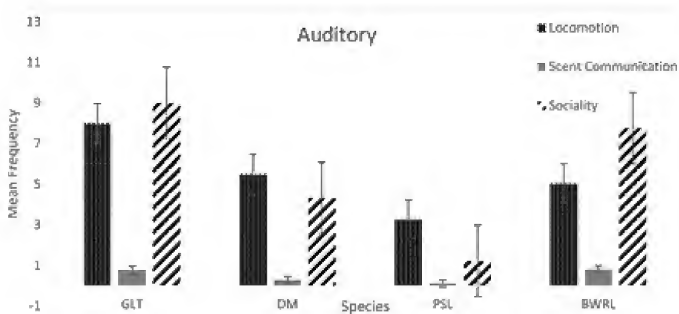
The evidence from this study suggests that nocturnal and diurnal primates react differently to sensory enrichment, potentially based on their contrasting natural histories. Therefore, when zoos are creating an enrichment program, the types of sensory enrichment provided should be guided by the primate species' natural history to be most effective. Having effective enrichment increases the quality of care and husbandry and, therefore, the welfare of the primates (Fuller et al., 2001; Armstrong, 2013; Brooker, 2016).



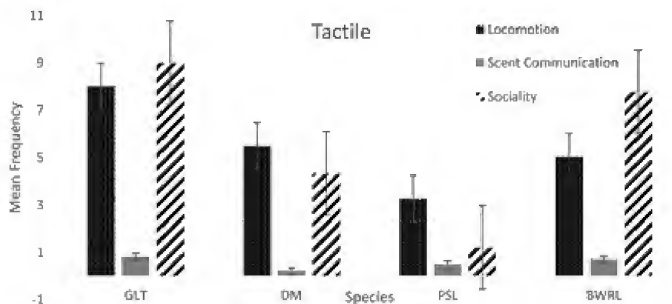
**Figure 2:** Mean frequency of Locomotion, Scent Communication, and Sociality with Olfactory Enrichment for GLT, DM, PSL, and BWRL



**Figure 3:** Mean frequency of Locomotion, Scent Marking, and Sociality with Visual Enrichment for GLT, DM, PSL, and BWRL



**Figure 4:** Mean frequency of Locomotion, Scent Marking, and Sociality with Auditory Enrichment for GLT, DM, PSL, and BWRL



**Figure 5:** Mean frequency of Locomotion, Scent Marking, and Sociality with Tactile Enrichment for GLT, DM, PSL, and BWRL

## References

- Armstrong, D., and R. Santymire. 2013. Hormonal and behavioral variation in pied tamarins housed in different management conditions. *Zoo Biology* 32(3):299-306.
- Bicca-Marques, J.C. and P.A. Garber. 2004. Use of spatial, visual and olfactory information during foraging in wild nocturnal and diurnal anthropoids: a field experiment comparing *Aotus*, *Callicebus*, and *Saguinus*. *American Journal of Primatology* 62:171-187.
- Bloomsmith, M., L. Brent, S. Schapiro. 1991. Guidelines for Developing and Managing an Environmental Enrichment Program for Nonhuman Primates. *Laboratory Animal Science* 41(4):372-377.
- Bloomsmith, M., and S. Lambeth. 2000. Videotapes as enrichment for captive Chimpanzees (*Pan troglodytes*). *Zoo Biology* 19(6):541-551.
- Braune, P., S. Schmitt, and E. Zimmermann. 2005. Spacing and group coordination in a nocturnal primate, the Golden brown lemur (*Microcebus ravelobensis*): the role of olfactory and acoustic signals. *Behavioral Ecology and Sociobiology* 58(6):587-596.
- Britt, A. 1998. Encouraging natural feeding behavior in captive-bred black and white ruffed lemurs (*Varecia variegata variegata*). *Zoo Biology* 17(5): 379-392.
- Brooker, J. 2016. An investigation of the auditory perception of western lowland gorillas in an enrichment study. *Zoo Biology* 35(5):398-408.
- Clark, F., and V. Melfi. 2011. Environmental enrichment for a mixed-species nocturnal mammal exhibit. *Zoo Biology* 29:1-17.
- Fitch-Snyder, H., and M. Jurke. 2003. Reproductive patterns in pygmy lorises (*Nycticebus pygmaeus*): behavioral and physiological correlates of gonadal activity. *Zoo Biology* 22:15-32.
- Hosey, G., V. Melfi, and S. Pankhurst. 2013. *Zoo animals: behavior, management, and welfare*. Second edition. Oxford, England. Oxford University Press.
- Jacobs, G. 1993. Photopigments and colour vision in nocturnal monkeys, *Aotus*. *Vision Research* 33:1773-1783.
- Jacobs, G.H., M. Neitz, J.F. Deegan, and J. Nietz. 1996. Trichromatic colour vision in New World monkeys. *Letters to Nature* 382:156-158.

- Jacobs, G., and J. Deagan. 2001. Photopigments and colour vision in new world monkey from the family Atelidae. *Proceedings of the Royal Society B* 268:695-702.
- Kantha, S.S., H. Koda, and J. Suzuki. 2009. Owl monkey vocalizations at the Primate Research Institute, Inuyama. *Neotropical Primates* 16(1): 43-46.
- Kerridge F.J. 1996. Behavioral enrichment of ruffed lemurs (*Varecia variegata*) based upon a wild-captive comparison of their behavior. Doctor of Philosophy thesis. Bolton Institute
- Kleiman, D., K. Thompson, and C. Kirk Baer. 2010. *Wild mammals in captivity: principles and techniques for zoo management* second edition. Chicago, USA. The university of Chicago.
- Mittermeier, R., A. Rylands, and D. Wilson. 2013. *Handbook of the mammals of the world*. Barcelona: Lynx Edicions-IUCN.
- Rapaport, L. 1998. Optimal foraging theory predicts effects of environmental enrichment in a group of adult golden lion tamarins. *Zoo Biology* 17:231-244.
- Rees, P.A. 2013. *Dictionary of Zoo Biology and Animal Management*. University of Salford, UK. Wiley-Blackwell Publications.
- Robbins, L. and S. Margulis. 2014. The effects of auditory enrichment on gorillas. *Zoo Biology* 33(3):197-203.
- Trevino, H., A. Skibiell, and K. Naugher. 2007. Comparison of serval types of enrichment for captive felids. *Zoo Biology* 26(5):371-381.
- Vaughan, T., J. Ryan, and N. Czaplewski. 2015. *Mammalogy: Sixth Edition*. Burlington, MA. Jones and Bartlett Learning.
- Young, R. 2003. *Environmental Enrichment for Captive Animals*. Oxford, England. Blackwell Publishing.

#### Acknowledgements

I would like to thank Dr. Cheryl Frederick and Dr. Jennifer Clarke as acting as my thesis advisors, Dr. Aimee Phillippi for supporting as my thesis professor, Professor Barry Woods and Melanie Jackson for help on my statistical analyses and the staff of Capron Park Zoo for allowing me to conduct this study with their animals. 🐾

#### Review by Heather Dunn and Stephanie Miner

This article highlights the importance of researching a species' natural history. By collecting and comparing this information for each of the species he was studying, the author chose enrichment items designed to engage different senses with the goal of encouraging different natural behaviors. Furthermore, by taking the time to observe the animals before and after they received the enrichment items, he was able to objectively compare behavioral responses and examine the value of the items.

While the data did not support all three of the author's predictions, the results still highlighted significant differences between the species, which allows the keeping staff to modify the enrichment programs of these species. By learning how these animals react and engage with different enrichment items and opportunities, staff is able to ensure they are providing appropriate experiences to ensure optimal welfare. This study also gave the author experience collecting and analyzing data, which is an essential tool as zoos and aquariums focus more on evidence-based management.

## BIG CAT INTERNSHIPS AVAILABLE



# Join us in

"Saving Tigers One by One"  
As seen on Animal Planet®  
"Growing Up Tiger"

Learn about Big Cat Management. Internship involves  
Animal Care Apprenticeship and Public Education.  
We offer experience that counts towards employment.



TIGER MISSING LINK FOUNDATION • TIGER CREEK WILDLIFE REFUGE • Apply at: [www.tigercreek.org](http://www.tigercreek.org)



CONSULTING & DISTRIBUTING, INC.

8620 E. Old Vail Rd., Ste. 100 Tucson, AZ 85747

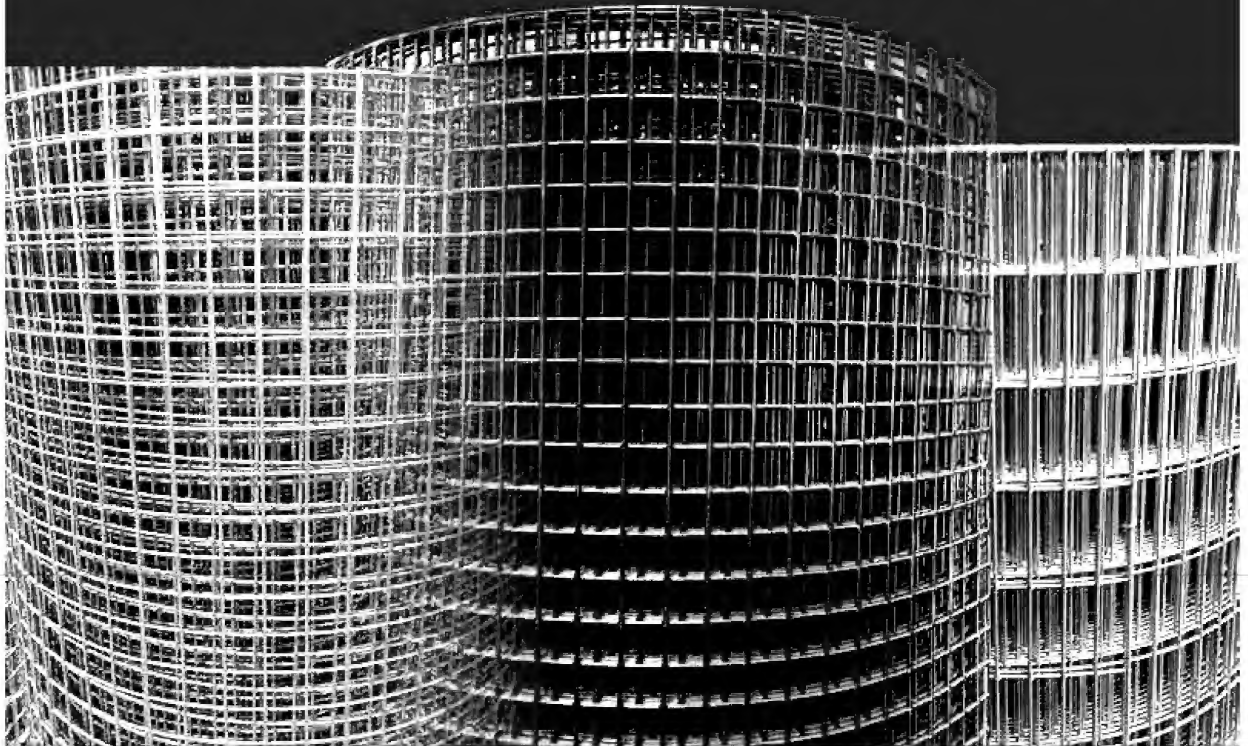
Ph: 520.434.8281 | Fax: 520.434.0151

Email: [info@athruz.net](mailto:info@athruz.net) | Website: <http://www.athruzcages.com>



*We carry in stock!*

**ROLLS OF WELDED WIRE • NETT'EM • VANISHING MESH • ZOO MESH**  
Maintenance / Repair / Installation Services by our experienced Field team!





# Lyon ProCare Critical Care Units

Through years of use in veterinary and teaching hospitals, emergency clinics, rescue facilities and zoological institutions, the Lyon ProCare Critical Care Unit (CCU) assists veterinary professionals in providing the best oxygen therapy care to a variety of animals.

Our largest units (CCU 48 and CCU 60) were designed with leading practitioners for larger animals such as chimpanzees to meet the demanding needs of critical care.

The goal of oxygen supplementation is to increase the oxygen concentration of inspired air, improve blood oxygenation, and increase tissue delivery of oxygen.

Lyon's Critical Care Units are great for avian and exotic patients because they are low stress and noninvasive. They are the go to unit for thousands of veterinary professionals world wide.



*CCU Bank: 18,36 and 60*

## DIMENSIONS:

ProCare CCU 18: 22 ¼ W x 22 H x 23 D P/N 912-120

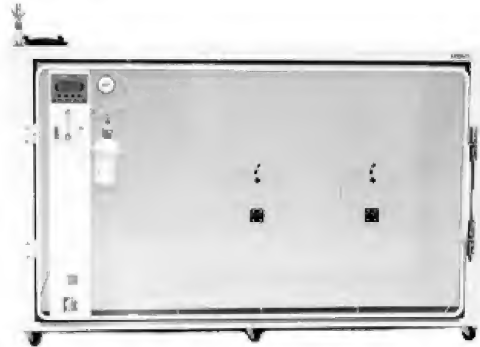
ProCare CCU 24: 28 ¼ W x 27 H x 23 D P/N 912-103

ProCare CCU 36: 40 ¼ W x 27 H x 23 D P/N 912-104

ProCare CCU 48: 52 ¼ W x 33 H x 25 D P/N 912-140

ProCare CCU 60: 66 ¼ W x 39 H x 31 ½ D P/N 912-119

\*All dimensions are in inches by Width X Height X Depth  
\*Specifications subject to change without notice



**ProCare CCU 48 912-140**

## STANDARD FEATURES

- 5 Sizes
- Double Walled, Insulated all Metal Construction
- Powder Coated for Superior Durability
- Digital Display
- Relative Humidity Display, Monitoring and Alarm
- Passive Cooling System
- Oxygen Induction System
- CO<sub>2</sub> Scrubbing
- Easy Lift Removable Door
- Auxiliary Access Port(s) depending on unit size
- IV Tube Access with Integrated Bag Holder
- Interior LED Lighting
- Nebulizer System
- Removable Floor
- Optional Cart with Storage Shelf and Casters
- Lyon TrueDimension™ Sizes are Actual Interior Useable Space
- Oxygen Inlet Terminated with DISS 1240 Male Adapter



8476 E. Speedway Blvd.  
Suite 204  
Tucson, AZ 85710-1728  
U.S.A.

"Dedicated to  
Professional Animal Care"



 [facebook.com/AAZKinc](https://facebook.com/AAZKinc)

 @AAZKinc

## Sound Nutrition for Nature's Royalty



Central Nebraska Packing, Inc. offers:  
**Classic & Premium** Frozen Carnivore Diets

• ALSO AVAILABLE •

HORSE SHORT LOINS / HORSE & BEEF BONES  
MEAT COMPLETE WITH TAURINE (RAW MEAT SUPPLEMENT FOR ALL CARNIVORES)

MEMBER: AZA | AAZV | AAZK

**NEBRASKA BRAND**

877.900.3003 | 800.445.2881

P.O. Box 550, North Platte, NE 69103-0550  
[info@nebraskabrand.com](mailto:info@nebraskabrand.com) • [nebraskabrand.com](http://nebraskabrand.com)

FELINE & SENIOR FELINE | BIRD OF PREY | CANINE | SPECIAL BEEF FELINE